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An Even Hundred Pages.

AT the Montreal convention THE ELECTRICAL WORLD received numerous kind words of commendation for its convention issue. Aside from the diversified mass of reading matter, its sixty pages of advertising, the largest number it has ever sent to a convention, formed substantial evidence of the magnitude and prosperity of the electrical industries. But at the present time, with a solid one hundred pages, all our previous records are broken, as they have not infrequently been before, and THE ELECTRICAL WORLD sends out to its readers this week the largest number ever published by any electrical journal.

The Electric Light Convention.

TAKEN all in all the convention of the National Electric Light Association at Montreal was the most successful in the history of the association. The attendance was large, the papers were of an unusual order of excellence, and the discussions, though less complete than has sometimes been the case, were full of useful suggestions. Aside from all this every one who attended the convention will long remember the courtesies shown by and the hospitable greeting received from the citizens of Montreal, and their untiring efforts to make the stay of their American visitors a thoroughly agreeable one. A word, too, ought to said in this connection for the hotel accommodations, which were unusually satisfactory. Perhaps the feature of the convention was the electrical exhibition, where was established what in all probability was the most complete collection of commercial electrical appliances that had ever been gathered together in this country. There have been exhibitions far larger and more pretentious, but for the most part they have partaken of a somewhat spectacular character that has detracted from their real usefulness to the working electrician. Owing to the kind offices of our Canadian friends and the number of charming entertainments that had been provided, it proved impracticable to hold more than one business session a day, so that the work of the convention was not ended until Friday, the 11th of September. In every respect the convention was highly satisfactory, in fact its standard of excellence was so high that it will be hard to equal and harder to surpass.

Safe Wiring Rules.

ONE of the most important pieces of work done through the agency of the National Electric Light Association in a long time has been the formulation by its committee of rules for the installation of electric work, both inside and outside. Such a committee has existed for several years, but it is only within the last six months, through the labors of the present members, that the work has been successfully accomplished. The committee selected to take charge of this important investigation was one exceptionally well constituted. It was made up of Messrs. A. J. De Camp and M. D. Law, central station men of long and wide experience, and Messrs. Stephen E. Barton and William Brophy, both experts in the inspection of electric light and power apparatus with reference to insurance, aside from their own experience in electrical work. As the result the set of rules published elsewhere in our columns was drawn up and met with very general approval. In some particulars it was modified when it came up for discussion before the convention, but in the main proved very satisfactory, and although not authoritatively adopted at this convention will doubtless receive official sanction later. The whole range of electric wiring is included, from the precautions to be taken for safety in the installation of machines up to the details to be observed in putting in incandescent or arc lamps. One of the very useful features of the report is a table of safe carrying capacities of wires, intended to represent conservative figures derived from experience. Inasmuch as hardly any two tables heretofore published agree within a considerable percentage, the present one, which has successfully passed the scrutiny of so competent a committee as that just mentioned, ought to be generally regarded.

The Lauffen-Frankfort Installation.

OUR correspondent at the Electrical Exposition, at Frankfort, gives in his letter published this week a most intesting account of the transmission of power from Lauffen, and particularly of the initial experiments over the line, of which he was a witness. It was certainly a daring feat to put into circuit with the distant power a motor of an unusual type, of unprecedented size, and which had never been tried at all before the current from Lauffen was turned upon it. The result was thoroughly successful, and evidence enough of the engineering skill that has carried the colossal experiment to a most gratifying termination. Thorough tests of the efficiency will probably be made ere long and we shall then be in a position to state definitely the probable usefulness of the particular kind of apparatus employed in establishing similar plants elsewhere. There is no reason to expect any serious breakdown; some minor difficulties may, and probably will, be encountered, as they are in every such new work, but up to the present they have been remarkably few and insignificant. Another interesting feature touched on in the letter is the introduction of numerous incandescent lamps operating on circuits as high as 150 to 200 volts with apparent success. If the German electricians have indeed succeeded in producing an efficient and durable glow lamp of this sort they have accomplished a very noteworthy feat, but at present we have no evidence of either long life or good efficiency.

The Management of Central Stations.

ONE of the most valuable papers read at the convention was a very thoughtful discussion of details in the care of large central stations read by Mr. James I. Ayer, himself manager of the largest arc light station in the world, as well as first vice-president of the National Electric Light Association. It is not our purpose to even attempt notice of all the important matters mentioned in the paper, but one of them it seems particularly appropriate to mention, and that is the absolute necessity of exact measuring instruments. Most central station men would naturally suppose, unless they had stopped to investigate, that an ammeter correct within .2 or .3 of an ampère was quite sufficient, and that if it should vary a little no special harm would be done. Apropos of this question, Mr. Ayer gives a few figures that are worth reproducing here. They are the result of experiments on a string of 10 lamps adjusted in the normal way for 9½ ampères and an average potential difference of 46 volts. The average watts per lamp was 436; when the current was permitted to rise to 9.8 ampères the average energy demanded was 524 watts per lamp, while at 10 ampères the same lamps required 550 watts, an increase of 33 per cent. This is, of course, the result of a lamp mechanism which on a stronger current adjusts itself for a longer arc. Inspecting these figures and noting that half an ampère increase in current means an increase of 33 per cent. in the energy demanded, it is easy enough to see that an error even so small as a tenth of an ampère in the measuring instruments may make a very serious increase in a year's coal bill, and few commercial measuring instruments, such as are supplied for station use, are accurate even to that amount. Careful testing of station ammeters and voltmeters by the use of the best available instruments is not therefore a refinement to be indulged in by the electrical expert; it is a very considerable factor in the commercial success of a plant. In a single case, for example, an investigation showed that a trifling accident to an ammeter increased the cost of fuel $16 a day. Another interesting piece of information given is that regarding the general efficiency of dynamos. Simultaneous power readings on the circuits, and indicated horse power at the engines, determined that on the average the ratio between indicated horse power and electrical horse power at the dynamo was 74.9 per cent., while the average output at the engine was very nearly .8 of a horse power per arc lamp. When the magnitude of the plant and the care with which regular observations are taken is considered, this figure is worthy of considerable confidence.

The Telephone Monopoly.

FOR some time there have been flying rumors and vague hints that the two greatest electrical monopolies of the world—the Western Union Telegraph Company and the Bell Telephone Company—were likely soon to engage in a terrific legal combat formidable from the multitudinous interests involved and the immense amount of capital that can be brought into play in such a struggle. It has been generally understood of late that the telephone company was not only contemplating means to secure a continuance of its patent rights but was preparing to open a particularly formidable line of competition over the long distance system so soon as the mutual understanding between the two great organizations shall have expired by limitation, as it will about the time of the expiration of the telephone patents. It has also been reported that such steps had already been taken in this line as to render legal action on the part of the Western Union Company probable. The struggle, however, has actually taken a different course. To understand the bearings of the question it is necessary to go back to 1879 when the Western Union Telegraph Company and the National Bell Telephone Company were struggling for the possession of the new business. The Bell patents were the key to the situation, but enough subsidiary apparatus was controlled by the Western Union to make a compromise necessary. A formal agreement was finally entered into by which the two companies were to have the monopoly respectively of the telegraph and telephone service. The Western Union company was to receive 20 per cent. of the receipts from the various rights held by the telephone company, in return for the use of Western Union patent rights and the monopoly of the telephone business. A dispute arose after four or five years regarding the interpretation of the contract with reference to the stock payments made by local companies in addition to the cash royalties, and in 1883 the Western Union company began action for an accounting involving something like $10,000,000. This suit was begun in the United States Circuit Court for the district of Massachusetts, and ex-Judge Lowell was appointed the referee. The decision of the referee was recently rendered and the accounting denied. Since that time the Western Union attorneys have been searching the records of the Bell patents and the holdings of Bell stock with special reference to the previous decisions of Judge Lowell, before whom have come several of the important telephone cases. They will now move to reopen the accounting case on the ground of evidence recently discovered, and should this motion be disallowed they threaten another to set aside Judge Lowell's decision on the ground that through his family he was largely interested in the Bell Telephone Company. In fact when Judge Lowell made his first telephone decision in the Spencer case in 1881 his own father is known to have held as collateral a large amount of telephone stock, and later Judge Lowell himself as referee in the case recently decided was at the same time executor of his father's estate and consequently interested in and responsible for the said stock. Aside from this fact the Western Union company has obtained some new evidence that will when brought officially forward make a sensation. Whatever may be the merits of the case an attack on Judge Lowell is a very serious matter. He is a man now nearly 70 years of age, belonging to a family distinguished even among the oldest Massachusetts families. His reputation has steadily grown through nearly a half century of legal practice and has been untouched until now by even a discreditable rumor. To attack such a man in the State and among the people where his character has remained stainless until he has nearly reached the allotted three score years and ten, evinces exceptional temerity or extraordinary evidence. What other line of attack may be opened by the Western Union cannot be foretold, but this much is certain, that the struggle generally believed to have been impending for some time is now very near at hand, and it is about time to see the forces deployed and to make some judgment as to the relative strength of their positions.

Latest Foreign Electrical News.

(By cable from our Own Correspondent.)

LONDON, Sept. 14, 1891.—The electric light work is progressing actively. The Portsmouth Municipal Light Company has just decided to devote £60,000 to the erection of a 10,000-light station.

The Glasgow municipality seems ready to take up the question of electric railroads, having just been inquiring into the best method of mechanical traction with a view to its adoption on the Glasgow tramway system in 1894 when it shall become municipal property.

The firm of Goulden & Trotter has just brought out a very ingenious safety mining cable designed to render arcing on the breakage of the cable practically impossible.

The death is just announced of Mr. L. J. Crossley, inventor of the Crossley telephone transmitter that has come into wide use in this country.

News from the Frankfort Exhibition.

(By Cable from Carl Hering, Special Correspondent of THE ELECTRICAL WORLD.)

FRANKFORT, Sept. 14, 1891.—The Electrical Congress has now ended. There was a large attendance, especially from Germany, the American electricians in particular being somewhat scarce. Among the best known of the foreign electricians present were Messrs. Preece, Forbes, Kapp, Crompton and Waltenhofen. There were few papers of any moment read. In fact, this part of the Congress was decidedly unsatisfactory. No international business whatever was transacted, and the two new units now pushing their way into prominence—the henry and gauss—were not adopted. The motor of the great transmission of power plant between Lauffen and Frankfort is now running admirably.

The Montreal Meeting of the National Electric Light Association.

Throughout Sunday, Sept. 6, the delegates to the Montreal Convention were gathering from all points of the compass as fast as the railway trains could carry them. The largest contingent, of course, was from New York, and the special train pulled out of the Grand Central station a little late, as special trains generally do, at 9:30. The journey northward was uneventful until when near Manchester, Vt., the engine struck work, perhaps because of the unwonted character of the load it was dragging. One cylinder was disabled, and most of the delegates got out to join the inquest. Mr. J. Carpenter Smith, on the end of a pry bar, rendered so valuable assistance to the engineer that finally the train started ahead with the remaining cylinder, and reached Rutland, where the Boston delegation, about 50 strong, was already waiting, and had been waiting for an hour and a half. The combination train was made up and rushed northward again without further mishap. At St. John the Montreal contingent was waiting to welcome the train, and marched through the cars headed by two bagpipers, who discoursed unearthly sounds until the train got under way. At midnight Montreal was reached, and the assembled crowd proceeded to the Windsor Hotel.

All day Monday arrivals continued. By reason of the multiplicity of entertainments that the hospitality of our Canadian friends had provided but one session was held each day, and the first, which was really a preliminary meeting only, met in Windsor Hall, at three o'clock on Monday afternoon, Sept. 7. President Huntley, of the association, was in the chair, and in a brief speech presented Prof. H. T. Bovey, chairman of the Montreal Citizens' Committee, who spoke a few words of welcome, and then in succession introduced the Hon. James McShane, mayor of Montreal, Sir Donald Smith, Sir William Dawson, Mr. Richard White, and others. All these gentlemen joined in giving the heartiest possible welcome to the Convention. For the United States, President Huntley, U. S. Consul Knapp and Judge Armstrong responded. Following Judge Armstrong, Mr. Erastus Wiman gave a brief address, joining with the gratitude of a member of the association the welcome of a Canadian to the visitors to his native land. Mr. Wiman especially called attention to the splendid work that had been done in the electric transmission of power, and made some interesting applications with reference to the great possibilities of electrical development in the city of Montreal.

President Huntley then read his address, dealing particularly with the modern central station and showing its tendency to develop a zonal system of distribution, employing for the service in each zone that particular class of apparatus best adapted to give good results at that particular distance.

President Huntley then read invitations from McGill University, the Art Association of Montreal, the Harbor Commissioners, and others, and after a vote of thanks had been passed in recognition of these, the meeting adjourned until the next morning, when the business at hand was the reports of the various committees appointed by the association.

The first committee to report was that on the relations between manufacturing companies and central stations, read by Mr. E. R. Weeks, of Kansas City. It was full of excellent suggestions centring around the proposition of an offensive and defensive alliance among central station men. Judge Armstrong, Mr. Wilmerding and Mr. Francisco took part in a vigorous discussion, warmly indorsing the necessity for united action of some sort. Mr. T. Carpenter Smith called attention to the good results that might be obtained by using as far so possible unpatented apparatus, and even making it, when it could be done economically. He felt that in this way the parent companies could be made to feel that the central stations were not entirely dependent on them, and expressed the opinion that there was enough unpatented apparatus to do a very large proportion of central station work if it were only put into use. After further discussion by Judge Armstrong, Mr. Nichols, Mr. Seeley and Mr. Burleigh, the committee, was continued with instructions to formulate a definite plan of campaign.

Mr. H. M. Swetland then presented the report of the Committee of Data. He said that information was very hard to obtain, and really all that it was possible for the committee to do at present was little more than to urge upon the Association the necessity of systematic and regular testing of apparatus, boilers, engines and dynamos. Too much stress, he added, cannot be laid on the need and advantage of just such work, and when careful testing becomes the rule instead of the exception the Committee on Data will be able to secure something in the way of useful information.

There was no report from the committee on the World's Fair, but instead Mr. J. A. Hornsby, secretary of the Electrical Section, reported on the work that had already been done, especially the grand missionary work that has been accomplished in bringing electricity into such an important place in the transmission of power for the exposition. The main building devoted to electricity will certainly be a credit to the country, and although the other electrical exhibits will be somewhat scattered they will be no less imposing. A vigorous effort will be made to hold a great international electrical congress. Suggestions have already been offered to this effect, and informal inquiries have even been made, with the result of receiving many cordial responses from all over the world. The exposition management will do everything in its power to secure an international congress, and it will lay the matter before the United States authorities at an early date. In response to a motion, a new committee on the World's Fair was appointed, consisting of Messrs. Sunny, Coleman, Hart, Royce and Price.

The electric lighting section of the Committee on Data, which was not ready to report at the beginning of the meeting, then read a brief report, dealing particularly with the classification of information which had been received. Apropos of this Mr. E. R. Weeks and Mr. Francisco drew attention to the false impressions produced throughout the country by the difference in cost of electric lighting in various cities. They called special attention to the fact that no notice seemed to be taken of the immense differences in running expenses, but that the public evidently assumed that if light could be furnished very cheaply in one place it could be furnished at an equally low price in all others.

The Committee on Legislation then reported through Judge Armstrong, its chairman, that owing to the lack of co-operation from members in various parts of the country little information could be presented. Messrs. Wilmerding, Francisco, Huntley and Scott gave some detailed account of the legislation that had been going on in their respective States. This topic then gave way to the report of the Committee on Underground Conduits, of which Mr. Francisco is chairman. There was very little to report and at the present time the committee preferred not to attempt any considerable discussion of the matter.

On Wednesday morning the first business taken up was the discussion of an important paper on the management of alternating current stations, read by Mr. T. Carpenter Smith at the previous Convention at Providence. The discussion resolved itself into an experience meeting, and Messrs. Ayer, Blaxter, Smith and Capt. Brophy gave some very interesting bits of practical information for the benefit of the association.

The Committee on Safe Wiring then reported. Judge Armstrong read the somewhat lengthy document that had been prepared. It was of so great importance and so thoroughly worked out that any off-hand discussion was quite out of the question, and the elaborate set of provisional rules that had been brought forward were ordered to be printed, in order that the report might be made a special subject for discussion at the very earliest moment.

At the conclusion of this discussion Mr. Redman's paper on Central Stations Operated by Water Power was read. It dealt mainly with the practical details of the work as carried out in Mr. Redman's station at Rochester, N. Y. Under the conditions there existing the water power installation is a very successful one. On account of the surplus of water the company is able to rent power to several important industries. The paper provoked a lively discussion, which drifted off into all sorts of side issues. Judge Armstrong called attention to the need of impressing on the public mind the occasionally very cheap service that could be obtained by water power. Apropos of this, Mr. Francisco went into the question of meters vs. the contract system of supply. In his own station both power and light were supplied by meter wherever it could be done, at the uniform rate of 25 cents per kilowatt hour. He approved of the meter, as it enabled an equitable adjustment of rates to be had whatever the service to which the meters were put. Messrs. Wilmerding and Ayer took the opposite view, contending that by contract, especially if based on the maximum load, better rates were obtained and more regular receipts. Mr. Scott then put in one of his usual keen inquiries, this time with respect to the actual economy that could be obtained by using water under ordinary circumstances. To this Mr. H. Ward Leonard and Mr. T. Carpenter Smith replied, both taking the view that there were many cases where a good steam plant would be cheaper than water power, even when the latter is available. Mr. Smith went so far as to say that the best use for water in an electric light station was for the purpose of condensation rather than as a source of power.

The next topic to receive consideration was Mr. H. Ward Leonard's proposition for a composite station to use both direct and alternating currents, employing the same network and feeding all or part of it by either system as required. This paper lead to a most interesting and vigorous discussion between the author and Mr. T. Carpenter Smith, who is an earnest champion of the alternating current system, and although Mr. Leonard expressly disclaimed any intention of advocating the three-wire system as against the alternating, the discussion took an extremely lively turn. Mr. Smith believed that not only was the alternating quite as reliable as the three-wire system of distribution but that it was more efficient and safer, for the danger of a high tension wire crossing the three-wire system and sending its dangerous current directly to the lamps was far greater than breaking the insulation between the primary and secondary coils of converters. He believed that as time went on high tension would be used in connection with transformer sub-stations, and held that the danger from fire in heavy mains of the direct current produced more danger to life than the direct peril of the high tension alternating system. After a prolonged discussion, mainly between the two principals mentioned, the session closed with the reading of Mr. J. J. Burleigh's paper on methods of arranging central station accounts and so classifying them as to lead to the greatest useful result with the minimum of labor.

At the opening of the fourth session, on Thursday morning President Huntley read very pressing invitations from Norfolk, Va., and Augusta, Ga., to hold the next Convention in one of these cities. There was rather a strong feeling in the Convention that the next meeting should be in the West or the South, but the invitations were referred to the executive session.

Captain Eugene Griffin, of the Thomson-Houston Company, then read an interesting paper on the development of the electric railway. He took the view that substantially the modern electric railway was the creation of three years, dating back to 1888, at which time there were 13 small roads of more or less experimental character in operation. On the first of last July there were no less than 354 roads running, the normal growth of a century crowded into a few years. The speaker laid especial stress upon the economic importance of electric rapid transit, and showed that the increase in the average speed of street cars from six to nine miles an hour would more than double the available living area of a city, and in so far would alleviate the condition of the working classes, in addition to rendering useful, suburban portions of the country that otherwise could not well be reached. Captain Griffin said that the dangers of electricity which have been so often overestimated are now gradually becoming to be known at their real value, which is very slight, and the result was shown in the rapid extension of electric systems. A brief discussion followed this paper, in which Mr. Hammer, Judge Armstrong and others took part.

Somewhat of a sensation was created by the Chairman reading a telegram to the effect that the special electrical census reports had been stopped on account of lack of funds. If this stoppage should be permanent the reports are in such an incomplete state that the good results that had already nearly been reached would be irretrievably lost. Even the stoppage of work until the next session of Congress, at which time the topic would be brought up, would be very serious. In response to this Dr. Mason presented the cause of the electrical fraternity in the most effective manner, and finally offered a resolution calling on the Secretary of the Interior to see that the work was continued, requesting the introduction of a proper appropriation bill at the next session of Congress, and endorsing the work that Mr. Foote had already accomplished in the electrical census. Judge Armstrong made a vigorous speech in the same strain and advocated the appointment of a special committee of the association to follow up the resolutions and look after the work in Washington. In response to this the president was authorized to appoint a committee of five to take personal charge of the resolutions and see that something was done in the matter. A resolution was also passed to engage the co-operation of other electrical bodies in attaining the same end of furthering the census work.

After this interpolated business the discussion of the report of the Committee on Safe Wiring, deferred from Tuesday in order to give a chance for the printing of the report, was taken up, after the president had been authorized to appoint a standing committee of five to take charge of further work on wiring rules. The various provisions of the report were then considered seriatim, and, as might have been expected, provoked in the main a lively discussion. Most of them passed without active discussion, but certain topics were vigorously debated, and a considerable number

of minor changes were made. The rules were provisionally adopted and some sections were held for reference to the standing committee just mentioned. Owing to the lateness of the hour the discussion was closed before all the rules had been taken up, and the remainder of the work was left to the committee.

The session terminated with the reading of Mr. C. J. Field's paper on Electric Railway Construction and Operation. This proved to be a most practical paper of great interest to those engaged in electric railway work, and it was most unfortunate that it was read at a time when proper discussion was almost impossible.

On Friday morning the two remaining papers were taken up. The first to be read was Mr. Ayer's very valuable and interesting account of the methods used in the management of the great central station of the Municipal Company in St. Louis. The descriptions of the methods and precautions to be observed in arc lighting was full of practical details that must prove immensely useful to any manager. Two points especially referred to were the necessity of careful testing of apparatus and instruments and the great effect of small changes in the current on the total energy required at the station. Mr. Ayer said on one occasion he had found that a slight accident to an ammeter was increasing the coal bill at the rate of $16 a day, inasmuch as a current only .2 or .3 of an ampère greater than the normal required 20 or 25 per cent. more energy on account of the action of the lamp mechanism upon the electromotive force required. The discussion was comparatively brief, but Messrs. Nicholls, Francisco, Seely and others gave some useful fragments of information from their own experiences, and several minor points were actively discussed.

The final remaining paper, Mr. Warner's practical treatment of the subject of Arc Light Carbons was taken as read, owing to the little time remaining, and after a small amount of casual business had been transacted Sir William Dawson, Mr. F. R. Redpath and Prof. H. T. Bovey were elected honorary members of the association. This terminated the public meetings, and the association then went into executive session. One important item of business transacted at this final meeting was the selection of Buffalo, the home of President Huntley, as the place of the next meeting of the association. The selection was satisfactory to the members, even to those who hoped for the selection of a more Western or Southern point. Three vacancies on the Executive Committee, caused by the expirations of the terms of office of Messrs. J. J. Burleigh, A. M. Robinson and E. W. Rollins, were filled by the election of Messrs. Frederic Nicholls, of Toronto; A. M. Young, of Waterbury, Conn., and M. D. Law, of Schenectady, N. Y.

Resolutions of thanks were then tendered on the part of the association to Lord Stanley, Governor General of Canada; to the City of Montreal; to the Committee on Exhibits, the press, the railway companies, and the management of the Windsor Hotel. The association then adjourned to meet again six months hence in Buffalo.

Novel Parcel Exchange System.

(From a London Correspondent.)

A rather novel, and at the same time ingenious, parcel exchange system has been devised by Mr. A. R. Bennett, a member of the Institution of Electrical Engineers, and a gentleman who is well known in connection with telephony in the United Kingdom. In many of the large towns of this country the vehicular traffic is so heavy that in order to avoid absolute blocking of the thoroughfares the collection or delivery of goods is forbidden in certain localities during business hours. The results of this restriction are that trade suffers, and warehouses have to be made of larger capacity than would be necessary if the free receipt and dispatch of goods were permitted. With a view to overcome this difficulty, and to allow of comparatively small packages being handled at all times, Mr. Bennett has worked out a scheme (which is founded upon the "telephone exchange" principle) by which parcels could be readily interchanged between any number of buildings, no matter how widely far apart they may be situated. It would occupy too much space to enter into the full details of the proposed system, but the following brief résumé may be found interesting:

The author proposes to effect this system of interchanging by the establishment of a number of miniature underground electric railways, radiating from a central station, and having branch lines or sidings into all the buildings to be served. According to this plan, the railways would be laid in tubes of a rectangular section, and would be so arranged that the down track would occupy the lower portion, and the up track the upper portion of the tube. The tubes would be made sufficiently large—the author proposes two feet wide by three feet high—to allow a man to creep through for examination and repairs, and in order to afford space for this the rails would be laid, not on cross sleepers or ties, but on brackets fastened to the walls of the tube. Trucks actuated by electromotors would run on the rails, the current being obtained either from one of the latter or from a separate conductor laid parallel with the track. On the down journey the current would be collected by a kind of shoe pressing against the under side of this conductor, and on the up journey by a second shoe or collector. Separate shoes are, however, provided and connected with the motor so that a truck could not travel in the wrong direction. The size of tube suggested by Mr. Bennett would permit of trucks 20 inches wide by 14 inches deep being used, and their length might be considerable, but it would be regulated by the radius of the curves.

Each train would consist of a motor truck, and one, or perhaps two or three trailers or other trucks. The generating and operating station would be established in a suitable locality; in a large town there might be several. The station would contain the engines, boilers and dynamos, and might also be used as an electric light station. Here would be arranged various turntables for the interchange of trains between the tubes, while sidings would be provided for empty trucks.

Coming now to the interesting point of delivery of goods, Mr. Bennett says that connection with the premises of subscribers would be made by short spurs or sidings diverging from the nearest main tube. At the junction of the branches with the main track, switches similar to ordinary railway switches would be placed and controlled by means of electromagnets by the operator at the central station. Various methods for finding and working any switch with certainty and rapidity are proposed, and also for ascertaining that the switch has been put over or *vice versa*. The sidings into subscribers' buildings would consist of down and up tracks, but where space is available they would be caused to diverge after entering the building and ultimately meet on one track, so that trains might be shifted from the down to the up track without lifting them off the rails. Various arrangements are provided for signalling and for informing the operator or operators of the progress or position of the trains, and for the return of loaded or empty trucks from subscribers' sidings or on the main up line. The starting levers could be interlocked with the levers controlling the siding switches, so that a following train could not leave until the switch for the preceding one had been restored to its normal position.

This scheme, which was fully set forth and illustrated by diagrams at the Cardiff meeting of the British Association, is rather startling, but Mr. Bennett considers that the details do not comprise any device which has not been thoroughly tested in the telegraph and signaling department of the post office and railway companies, or in connection with electric traction. He is of opinion that the system of electrical parcel exchange as proposed would be invaluable to the various post offices, and to parcel receiving and great despatchers of small packages; buyers could, he says, telephone for samples, hotels and restaurants could telephone for and receive in a few minutes supplies they may be short of, etc. As a parting shot, Mr. Bennett gives a friend's suggestion that a mother could send her baby bodily to the doctor *via* the central station, and receive it back with "a bottle of medicine in its fist and a mustard leaf on its chest."

Electrical Practice in Europe as Seen by an American.—IV.

BY CARL HERING.

The exhibition may now be said to be practically completed, but with the exception, unfortunately, of the one great exhibit, which is attracting so much attention in the electrical fraternity all over the world, namely, the transmission of power from Lauffen. It is unfortunate that there are so many delays; but to one who knows the facts in the case, it is quite comprehensible that such delays occur, and it should be said here that the delays are not due to the company nor the electrical engineers in charge of the works. It will be remembered that the companies whose exhibit this is were under penalty of a heavy fine to be ready to start on August 15th, and as far as they were concerned, all the apparatus was finished and erected, but the postal authorities (German government), who it appears were not under penalty of a fine, were not ready with the line which they had undertaken to construct. This caused a delay of over a week or more, which included some more or less reasonable formalities before it was officially turned over to the exhibitors for use. It was therefore not until a few days ago that the exhibitors could start their trial and experiments.

There are so many novel features about this experiment—for it is in every sense a public experiment, as distinguished from an exhibit of a commercial, model installation—that any engineer who has ever experimented with new apparatus and systems will readily understand that it is quite necessary to proceed carefully and cautiously. The impatient public, however, who are not aware of the difficulties involved, and who do not appreciate the need of proceeding with care, are already drawing unfavorable conclusions, which, however, are not warranted at all, as the writer, who knows the causes of the delays, will vouch for; they are, at least, not warranted at present; what the future will develop we cannot know, nor would we venture to prophesy, except to say that, from what was seen here, the system is no doubt a success, probably a complete success; but whether it will be possible to confine such a high tension current—a truly vicious current—to the line wires is still quite uncertain; if it is possible it is still a question whether it is practicable for commercial purposes. It is to decide this question that this very interesting and costly experiment is being made; and it is only rival companies, and a few pessimistic prophets, who do not wish these bold and enterprising exhibitors success.

The present state of the case is as follows, all other statements to the contrary notwithstanding: As the experiments are made with closed doors, the public have no means of knowing the exact condition of affairs. The writer, however, was one of the few who had the pleasure of witnessing the first arrival of the current from its distant generator. In order to be assured of the proper working of the line, and to see whether it would carry the current at all, which was by no means certain, the secondary current of 12,500 volts was first sent through a bank of lamps at this end, instead of through the motor. This proved a success in apparently every respect; the lamps burned as normally as the calculations intended they should.

The current was then sent through the large and novel motor, which started slowly and gradually under complete control of the engineer, until it reached its predetermined speed, at which it remained running without any adjustments whatsoever, making no more noise than the low humming of any ordinary transformer; it was indeed a novel sight to see such a large motor running without the slightest noise or vibration. It was a triumph of intelligent calculation, as this motor had never been run before, owing to the fact that the generator was built in Zurich and the motor in Berlin, and as it could be run only with this particular three phase-alternating current, it could not be tried until it was mounted here, and received current from its distant mate. Furthermore, it was the first one of that size ever built. The only other one from which experimental data could be obtained was a small one of about one h. p., almost a mere toy in comparison. As it is not a synchronous motor, as other alternating current motors are, the fact that it reached its predetermined speed and remained there, showed, in a measure at least, the correctness of the design. Owing to a hot bearing in the pump the latter could not be run; up to the present, therefore, the motor has not been run loaded, except for a few minutes, too short a time to draw conclusions.

In order to load the transformer fully, as well as to show the public that the current really got here from Lauffen (where the generator is situated), a large bank of lamps encircling a huge sign in front of the exhibit was turned on; they burned brightly, showing that the current not only got here, but that the load was not as great as was expected and prophesied by some. Owing to the breakage of an insulator on the line the current had to be turned off. This last experiment was made yesterday morning and includes the tests made up to the present writing. There were a few delays due to things which are apt to happen in starting any large new installation, but the only evil effect of these is to influence the minds of the impatient public. The interest and impatience are very great, especially as there is at present a municipal congress of the mayors of many German cities here, and it was the intention to start the transmission with great ceremonies during the session of this congress. Possibly it may yet be accomplished.

As soon as it is possible to obtain detailed information the writer will send a full description of this very interesting and novel installation. At present it will suffice to say that the system is designed and invented by M. von Dolivo-Dobrowolsky, a Russian by birth, well known as one of the leading electrical engineers of Germany. He is the electrical engineer of the Allgemeine Elektricitäts Gesellschaft of Berlin, who, together with the firm of Oerlikon (Zurich), are the exhibitors. Whether he is the first inventor need not be discussed here, any more than to say that he was probably not the first to conceive the idea of a rotary current, but that he was probably the first to put it into practice on a large scale and with novel details. The first mentioned firm built the motor, and two of the transformers, all designed by Mr. Dobrowolsky. The firm of Oerlikon built the generator,* which was designed by their engineer, Mr. C. E. L. Brown, who is well known for his very creditable work in dynamo construction. They also built two of the transformers modified in details by Mr. Brown. The line was erected by the government postal authorities, the copper wire being furnished by Hess & Sons, of Heddernheim, near Frankfort.

The three-phase rotary alternating current (drei-Phasiger Drehstrom) consists, as is well known, of three alternating currents differing from each other by one-third of a wave length. Such a current is particularly well suited for motor purposes, as already shown by the well known Tesla motors, in which a similar current is used. The current is transformed from 50 volts at the generator to 12,500 volts by a transformer; at the other end it is transformed back again, and then goes to the motor or lamps as desired. The line has three wires; the generator, motor and transformers have four.

It should be clearly understood that this experiment must not be looked upon as a test to show how much of the actual power of the generator is recovered at the motor. For such a test the line is very poorly proportioned and would give very misleading results. The main questions to be determined are, whether it is at all possible to transmit an alternating current at such high potentials along such an air line on poles; whether the insulation of such a line is possible and practicable; what effect rain has on the insulation, etc.; and if such transmission is at all possible, then to determine by means of tests such figures as are necessary for an engineer to calculate whether an installation of this kind can be made practicable in specific cases, and if so, what the constants are with which he can determine the

*See THE ELECTRICAL WORLD, vol. XVIII., p. 126.

most favorable proportions. It should be regarded, therefore, as an experiment made to obtain the figures for calculating a plant, rather than to determine the actual efficiency of this particular plant, which is of little interest to the intelligent engineer, although the public do not look at it in the same way.

GENERAL EXHIBITION NOTES.

A general tour through the grounds and buildings shows that the progress of electrical engineering here has been a steady and healthy one, and with the exception of the introduction of the rotary alternating current there is no novelty of great importance. There are many modifications of dynamos, systems, etc., showing the natural and steady growth and progress of an important industry in

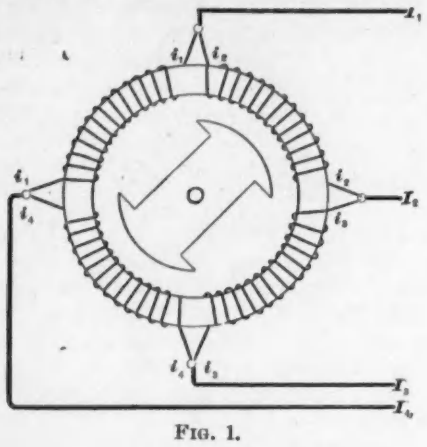

Fig. 1.

which no great monopoly exists in the form of broad fundamental patents, or artificial trusts and combinations, which are such an obstacle to a natural, healthy competition in which the fittest and not the strongest survive. The spirit here appears to be to make the best goods, rather than to pride themselves on their ability to sell something, or to keep others from selling it. The growth of electric lighting and transmission of power is slow here as compared with the United States, but it is steady and sure, and it is not unlikely that the larger European cities will have well planned, regulated and universal electric lighting before the larger American cities. Here the matter of lighting a city is referred to a committee of impartial technical experts, and not to ignorant politicians and contractors; it is

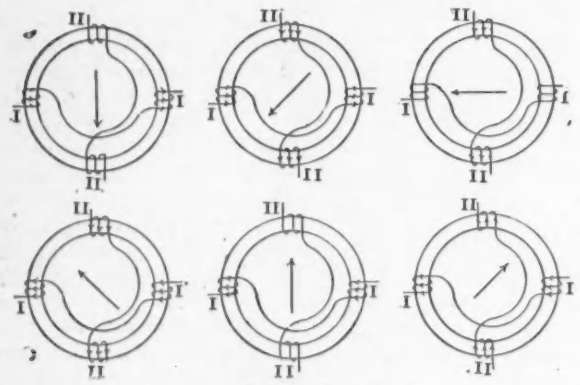

Fig. 2.

not likely either that the "lowest bidder" necessarily is accepted.

In numbers and in varieties of shapes the continuous current dynamos excel, but among the very large machines the alternating current dynamos are about as well represented as their rivals. The direct current systems, however, greatly outnumber the alternating; alternating current transformers are quite rare, while continuous current transformers (double wound dynamos) are comparatively numerous. Judging from the exhibits, transmissions with high tension continuous currents are quite numerous. One very noticeable feature of the exhibits is that the introduction of accumulators for central stations is growing apidly and steadily. The accumulator used in most of

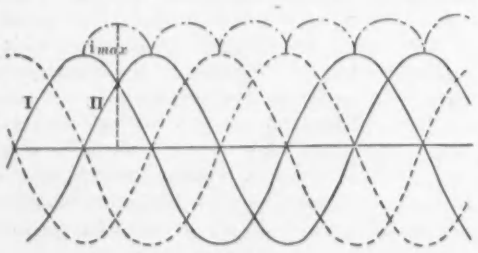

Fig. 3.

them is practically a Planté cell; it was very wisely concluded that for central stations lightness of weight at the expense of durability was poor economy. The present plates are made strong and heavy, and consequently are well able to stand the strains without danger.

Transmission of power by both alternating and continuous currents is one of the principal features of this exhibition. In the former, the tendency is toward multiple phase alternating currents. There is some ill feeling here as to who the inventor of this system is and who has the right to use it, but it is quite likely that it originated in the United States and is public property here. This has reference to what might be called an elementary rotary current of two or three phases. Regarding a new and interesting system of multiple phase currents with numerous phases we will have more to say in subsequent correspondence.

In incandescent lights, a marked improvement is the introduction of 150-volt lamps, and even up to 200 volts. Arc lights here are remarkably steady as compared to our flickering lamps. They are usually run in multiple arc, with incandescent lamps.

The exhibition itself includes many attractions for the public; no trouble has been spared to make it attractive in this respect. A layman can readily find something of interest there, even if he cannot understand it. The illuminated dome of the machinery hall, the colored waterfalls, the large projectors on the towers, with their club-shaped beams of light, all form an interesting sight in the evenings. The attendance, though fair, is not as great as was no doubt expected.

Last week a large party of Austrian and Italian engineers visited the exhibition in a body, and were entertained with

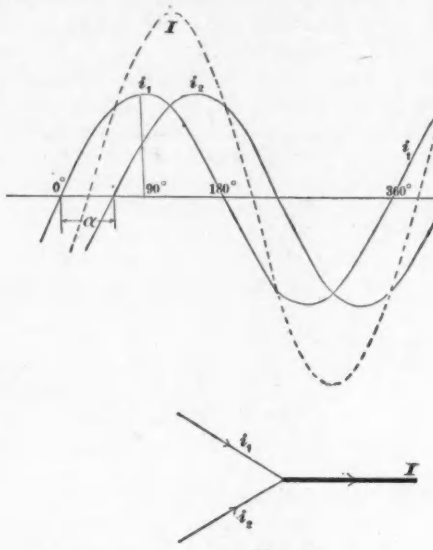

Fig. 4.

ceremonies. At present there is here a congress of cities, composed of the mayors and other municipal officers of about 50 of the most important German cities. They are being entertained as the guests of the city of Frankfort, and are being instructed in the fact that electric lighting for cities is no longer a novel experiment.

THE LAUFFEN-FRANKFORT INSTALLATION.

The occasion of the transmission of power from Lauffen to Frankfort has brought to the notice of the profession more than ever before the two or three phase alternating current system, described as early as 1887-8 by various electricians, among whom are Tesla, Bradley, Haselwander and others. As to who first invented it, we have nothing to say here, but though known for some years it has not until quite recently been of any great importance in practice.

Within the last few years, however, Mr. M. von Dolivo-Dobrowolsky, electrical engineer of the Allgemeine Elektricitäts Gesellschaft, of Berlin, has occupied himself with these currents. His success wi h motors run with such currents was the origin of the present great transmission of

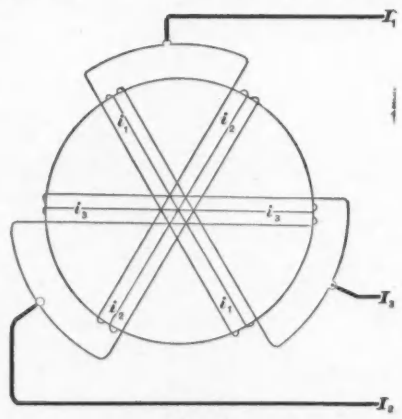

Fig. 5.

power exhibit at Frankfort, the greatest transmission ever attempted. His investigation in this new sphere, and his ability to master the subject from a theoretical or mathematical standpoint, has led him to find the objections, the theoretically best conditions, etc. This, together with his ingenuity, has led him to devise an entirely new and very ingenious modification, which will no doubt have a very great effect on the development of alternating current motors.

It is doubtless well known that if as in Fig. 1 a Gramme ring armature is connected to leads at four points as shown and a magnet is revolved inside of it (or if the ring is revolved in a magnetic field and the current led off by contact rings instead of a commutator) there will be two alternating currents generated, which will differ from each other in their phases only. When one is at a maximum the other is zero. When such a double current is sent into a similarly constructed motor it will produce or generate what might be called a rotary field, which is shown diagrammatically in the six successive positions in Fig. 2. The winding here is slightly different, but it amounts to the same thing as far as we are concerned at present. This is what Mr. Dobrowolsky calls an "elementary" or "simply" rotary current, as used in the Tesla motors. A similar system, but having three different currents instead of two, is the one used in the Lauffen transmission experiment referred to above.

In investigating this subject Mr. Dobrowolsky found that the best theoretical indications for such a system would be a large number of circuits instead of only two or three, each differing from the next one by only a small portion of a wave length; the larger their number the better theoretically. The reason is that with a few currents the resulting magnetism generated in the motor by these currents will pulsate considerably, as shown in Fig. 3, in which the two full lines show the currents differing by 90 degrees. The dotted line above these shows how much the resulting magnetism will pulsate. With two such currents this variation in magnetism will be about 40 degrees above its lowest value. Now, such a variation in the field is undesirable,

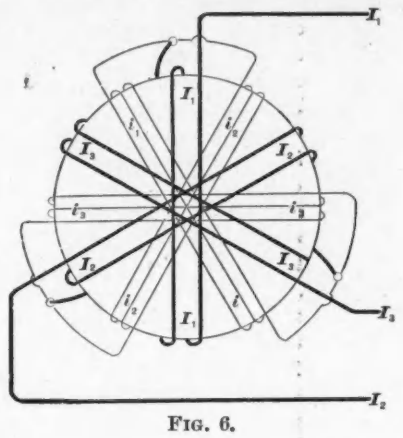

Fig. 6.

as it produces objectionable induction effects, and it has the evil effect of interfering with the starting of the motor loaded, besides affecting the torque considerably if the speed should fall slightly below that for synchronism. A perfect motor should not have these faults, and it is designed to obviate them by striving to obtain a revolving field in which the magnetism is as nearly constant as possible.

If there are two currents differing by 90 degrees, this variation of the magnetism will be about 40 per cent.; with three currents differing 60 degrees, about 14 per cent.; with

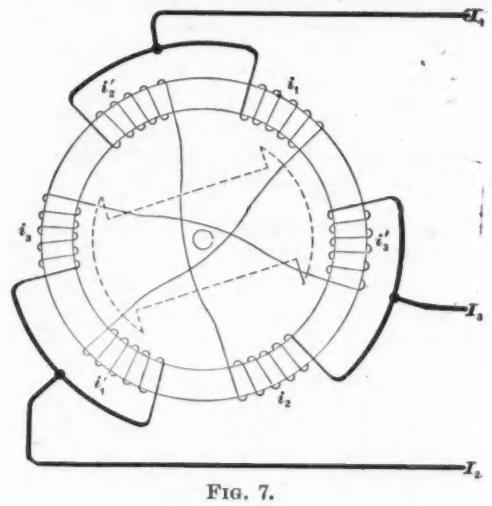

Fig. 7.

6 currents differing 30 degrees it will be only about 4 per cent., and so on. It will be seen, therefore, that by doubling the three-phase system the pulsations are already very greatly reduced. But this would require six wires, while the three-phase system requires only three wires (as each of the three leads can readily be shown to serve as a return lead for the other two in parallel). It is to combine the advantages of both that he designed the following very ingenious system. By this system he can obtain as small a difference of phase as desired, without increasing the num-

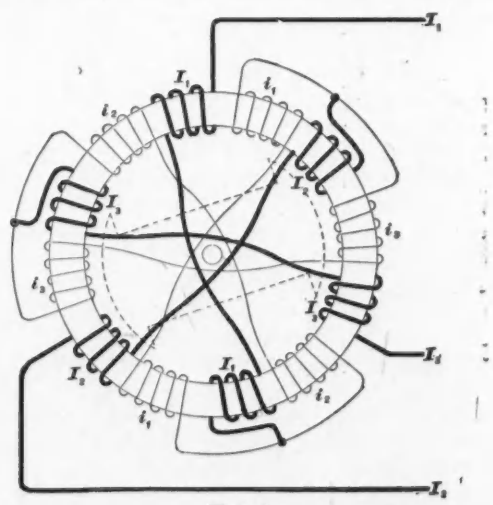

Fig. 8.

ber of wires above three, a statement which might at first seem paradoxical.

Before explaining this ingenious system, it might be well to call attention to a parallel case to the above in continuous current machines and motors. The first dynamos were constructed with two commutator bars. They were soon found to work much better with four, and finally still better as the number of commutator bars (or coils) was increased,

up to a practical limit. Just as the pulsations in the continuous current dynamos were detrimental to proper working, so are these pulsations in few-phased alternating current motors, though the objections manifest themselves in different ways—in the continuous current motors as sparking and in the alternating current motors as detrimental inductive effects.

The underlying principle of this new system may be seen best in Figs. 4, 5, 6, 7 and 8. In Fig. 4 are shown two currents, I_1 and I_2, which differ from each other by an angle D. Suppose these two currents to be any neighboring currents in a simple rotary current system. Now, if these two currents be united into one, as shown in the lower part of the figure, the resulting current I will be about as shown by the dotted line; that is, it will lie between the other two and at its maximum point, and for a difference of phases equal to 90 degrees it will be about 1.4 times as great as the maximum of either of the others; the important feature is that the phase of this current is midway between that of the other two. Fig. 5 shows the winding of a cylinder armature, and Fig. 7 that of a Gramme armature for a simple three-phase current with three leads, with which system we assume that the reader is familiar.

The two figures, 4 and 5 (or 7), correspond with each other in so far as the currents in the three leads, shown in heavy lines, have a phase between those of the two which compose them. Referring now to Fig. 6 (or 8), which is precisely like Fig. 5 (or 7) except that it has an additional winding shown in heavy lines, it will be seen that each of the

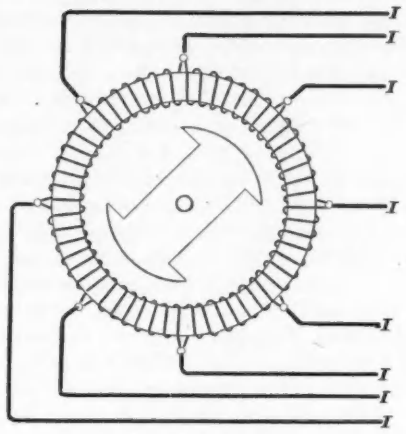

FIG. 9.

three leads, shown in heavy lines, is wound around the armature before leaving it, forming an additional coil lying *between* the two coils with which it is in series. The phase of the heavy line currents was shown in Fig. 4 to lie between the other two, therefore, in the armature in Fig. 6 (or 8) there will be six phases, while in Fig. 5 there are only three, the number of leads (three) remaining the same as before. This is the fundamental principle of this ingenious invention. To have six phases in Fig. 5 would require six leads, but in Fig. 6 precisely the same result is obtained

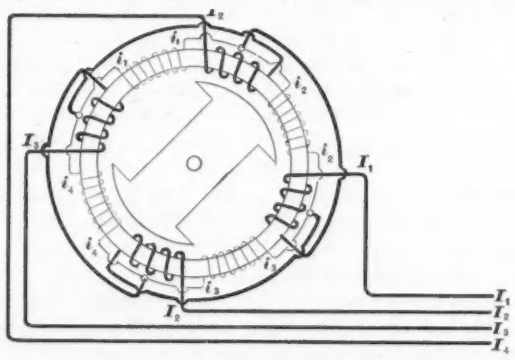

FIG. 10.

with only three leads. In the same way the three leads in Fig. 6 might again be combined and passed around the armature again, and so on forming still more phases, without increasing the number of leads. Figs. 7 and 8 compound with 5 and 6 and show the same system for a Gramme ring instead of a cylinder armature.

As was stated in the early part of this description, the main object in a rotary current motor is to have a magnetic field which is as nearly constant in intensity as possible, and which changes only its position, that is, its axis. But in Fig. 4 it was shown that the current I (in dotted lines) is greater than the others (about as 1.4 to 1 for a phase difference of 90 degrees). If therefore the coils in Fig. 6 or 8 were all alike the magnetism generated by the heavy line coils would be greater than that generated by the others, and would therefore produce very undesirable pulsations in the magnetic fields; but as the magnetism depends on the ampère turns, it is necessary merely to have correspondingly fewer turns on these coils, as compared with the others. This is shown diagrammatically in Figs. 6 and 8, in which the heavy line coils have less windings than the others. In practice it is not always possible to obtain the exact ratio of 1 to 1.4, for instance, but even if this ratio is obtained only approximately, it nevertheless reduces the pulsations very materially below what they would be with half the number of phases. It is therefore not necessary in practice to have more than an approximation to the exact conditions.

Fig. 9 shows a multiple phase armature, having double the number of phases as Fig. 1, and would according to the old system, therefore, require eight leads. Fig. 10 shows the new system with the same number of phases as in Fig. 9, but requiring only four leads instead of eight. Figs. 11 and 12 correspond with Figs. 7 and 8 and show the windings for a multipolar motor in the two systems.

These figures show how a motor may be wound so as to

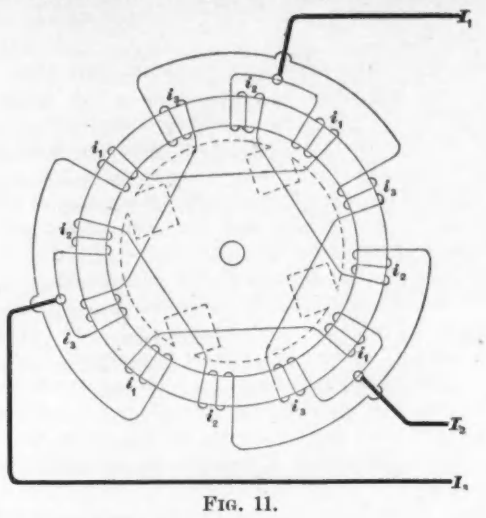

FIG. 11.

be a multiple phase motor, although the current entering the motor is a simple, elementary three or two phase current, which can be transformed by means of a simple three or two phase current transformer, before entering the motor, such transformers as are used at present in the Lauffen-Frankfort transmission. But the same principle as that for the motor may also be applied to transformers themselves, as shown in Figs. 13 and 14. Fig. 13 shows a set of transformers which are fed by a simple three phase current shown in heavy lines, and which gives in its secondary circuit a multiple phase rotary current. The connections for the primary circuit of a transformer with six coils are shown diagrammatically in Fig. 15, the numbers 1 to 6 representing the succession of the phases. Fig. 14 shows

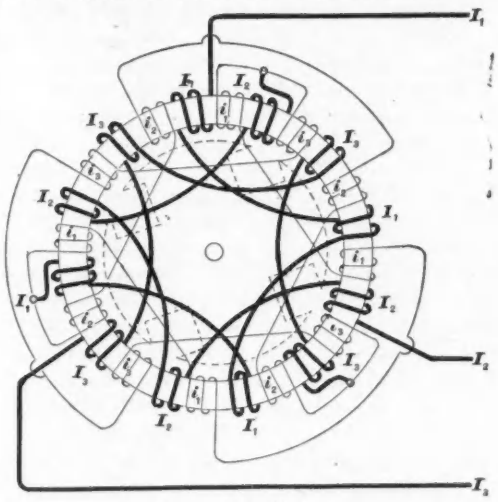

FIG. 12.

a transformer for a two phase current with four leads, transforming into a multiple phase current of 16 leads. The transformer in this figure is a single "interlocked" transformer in which the fields are magnetically connected and not independent of each other as in Fig. 13. This has advantages in the regulation of currents, which do not exist in Fig. 13, but which need not be entered into here. The transformers used in the Lauffen-Frankfort transmission are similar, magnetically, to Fig. 14, only that they are for a simple three phase current in both primary and secondary circuits. Attention is also called to the difference in the connections of secondary circuits in Figs. 13 and 14; in the former they are connected in a closed circuit similarly to an ordinary closed circuit armature, while in Fig. 14 they

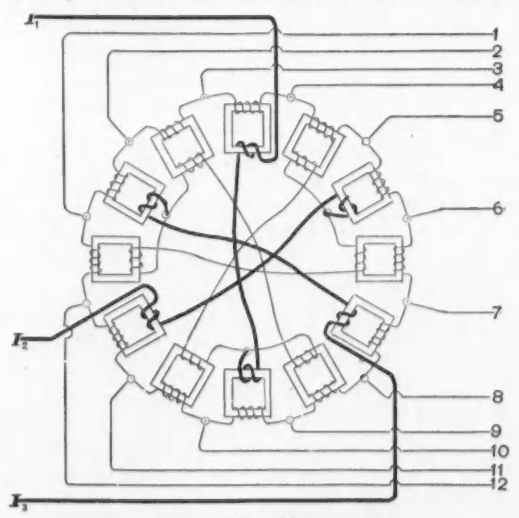

FIG. 13.

are independent as far as the currents themselves are concerned, though magnetically their cores are connected. It is not the intention to enter into a discussion of the relative values of these various connections, but merely to draw attention to the wide range of the number of combinations which this system admits of.

FRANKFORT O. M., Aug. 29, 1891.

Electricity at the World's Fair.

The Executive Committee of the Local Board of Managers of the World's Fair met last week and passed a resolution requesting the director general to send Mr. John P. Barrett, or a representative of the electrical department, to Europe, for the purpose of creating some enthusiasm in behalf of that department. It is expected that some such representative will be sent in the near future.

A special official report of the work of the electrical department since its organization made by Mr. Barrett to the director general is given below. This will form a part of the report of the director general to the National Commission and will be embodied in the report of that Commission to Congress.

"The Department of Electricity was organized on Feb. 14, 1891, by my appointment as chief. My first work after appointment was to gather about me representatives of the electrical interests of this country, and to ascertain their wishes in regard to the exhibition, and to lay out with their aid a complete scheme for the department. It became a part of my business to ascertain in a general way what the electrical people contemplated doing in a financial way for

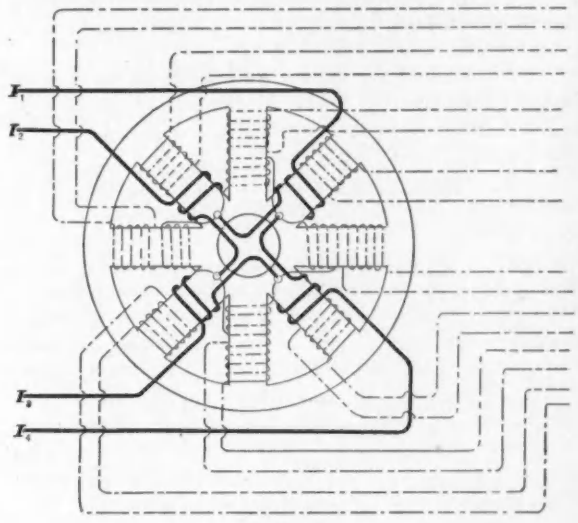

FIG. 14.

the success of the exposition. This I have done with most gratifying results. The electrical people are enthusiastic in their work. The boards of directory of most of the corporations have appropriated sums of money for the installation and maintenance of their exhibits, varying in amounts from $5,000 to $150,000. A large majority of these concerns have already begun preparations for their exhibits, and I have been in consultation frequently with them as to details. I am able to assure you, therefore, that the electrical department of the exposition will meet the requirement of its most enthusiastic friends.

"Up to the present time specific applications for space, including particulars as to power, etc., required, have been received from 30 firms or individuals, aggregating a de-

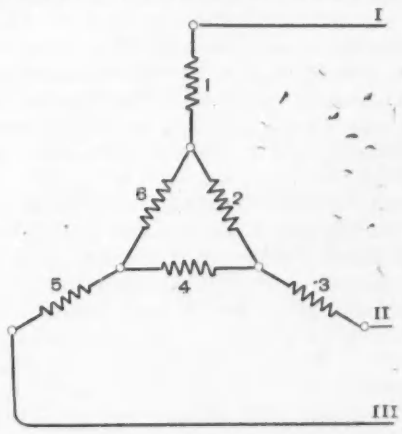

FIG. 15.

mand for 55,377 square feet of floor and wall space. In addition to these I have tentative or preliminary applications from 43 firms or individuals aggregating a demand for 62,300 square feet of space. These applicants have not been able as yet to decide precisely as to their requirement, and await at the present time certain information at the hands of this department. We have heretofore been unable to furnish this information. Still, in addition to these applications, I have letters from 59 concerns notifying the department of their intention to exhibit, but who have up to the present time failed to go further than such notification; their demands for space, however, will aggregate 75,000 square feet. These applications represent a total demand for 192,677 square feet of space in the electrical building. The larger concerns of this country have failed to send in their applications, but the work of preparation for the exposition is well under way in their factories. They require, before applying for specific space, certain information as to the supply of power, lighting, etc., for the exposition. As soon as these vexed questions can be finally settled, I will be able to furnish a complete list of the electrical interests in this country from my application files.

"Notification of the intended participation of the foreign electrical people comes under the existing laws, through the commissioners of foreign states. I have up to the present

time declined to go actively in the field for foreign exhibits as I believed a general enthusiasm should be created among foreigners by some movement on the part of your administration. Such action has recently been taken, and this department, not the least of any, has experienced the most gratifying result. There are reasons to excuse foreigners from great enthusiasm in regard to the exposition. Electrical expositions are overdone in Europe. The electrical people are under a constant drain in the way of expense for their maintenance. They have grown tired of expositions, therefore. They cite our laws as procluding the advantage which ought to result from an exhibition of their goods. They admit our superiority in electrical work—at least in some directions—and hesitate to compete with us. It will require an effort, therefore, and a subtle presentation of the advantages to accrue from their participation, to induce foreign electricians to make the effort that will be required. This must be a personal effort. Foreigners have many things in electricity which we would do well to know. They are our superiors in artistic features of the work, and their patient methods have brought them to perfection in some directions at which we have not arrived. A spirit of rivalry must therefore be developed in their minds, and when I have completed preliminaries for this work I shall ask that a representative from this department be sent among them.

"I conceive the time to be ripe for holding at the World's Columbian Exposition a great international electrical congress. I have engaged the creation of a sentiment in this behalf since the date of my appointment, and am almost prepared to announce my success. Such a congress will be of world wide interest. It will bring together the most famous men of our time, will create active discussion of issues vital to civilization, and will unquestionably prove of lasting benefit to the exposition and to the new science.

"From this time forward our campaign will be an active one. Electrical conventions of various classes are constantly occurring and at each of these I will have a representative. Department interest will be shown continuously in the preparation of exhibits in the factories of the electrical companies, and the deference to their wishes will be made a rallying point of enthusiasm. The electrical periodicals are placed at the disposal of the department and their columns will be constantly employed.

"At the present time I am at work upon special features including spectacular effects for our exhibit, and shall undoubtedly be able to command for the exhibition new electrical apparatus and new principles that will make a bright epoch of the World's Columbian Exposition of 1893."

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Chronological History of Electricity, Galvanism, Magnetism and the Telegraph, from B. C. 2637 to A. D. 1888.—Part I.*

BY P. F. MOTTELAY.

A. D. 1769.——St. Paul's Cathedral, London, is first provided with lightning conductors. Dr. Tyndall, who mentions this fact (Notes of Lecture VI., March 11, 1875) likewise states that Wilson, who entertaintained a preference for blunt conductors as against the views of Franklin, Cavendish and Watson, so influenced King George III. that the pointed conductors on Buckingham House were, during the year 1777, changed for others ending in round balls.

See Sturgeon's *Annals*, vol. X., pp. 127–131; also, Biography of John Canton in "Ency. Britannica;" Sir John Pringle, at A. D. 1777.

A. D. 1769.——Mallet (Frederick) member of the Royal Society of Upsal and of the Stockholm Academy of Sciences, acting upon the observations of Anders Celsius (A. D. 1740), is the first to make an attempt to determine the intensity of magnetism simultaneously at distant points. He finds that the number of oscillations in equal times at Ponoi, China (latitude, 67 degrees 4 minutes north; longitude, 41 degrees east) are the same as at St. Petersburg, Russia (59 degrees 56 minutes north latitude; 30 degrees 19 minutes east longitude).

See Walker, "Magnetism," chap. VI.; "Novi Commen. Acad. Sc. Petropol.," vol. XIV., for 1769, part 2, p. 33; Le Monnier, "Lois du Magnétisme, etc.," 1776, p. 50; "Biog. Univ.," vol. XXVI., p. 258.

A. D. 1770.——The well-known work of Jas. Ferguson, F. R. S., which first appeared under the title of "Introduction or Lectures on Electricity," afterward becomes still more popular under the head of "Lectures on Select Subjects, etc." (See, also, his "Lectures on Electricity," corrected by C. F. Partington, with appendix, London, 1825.)

In his first lecture he says that the most remarkable properties of the loadstone are: 1°, it attracts iron and steel only; 2°, it constantly turns one of its sides to the north and the other to the south, when suspended to a thread that does not twist; 3°, it communicates all its properties to a piece of steel when rubbed upon it without losing any itself. He cites the experiments of Dr. Helsham, according to whom, says he, the attraction of the loadstone decreases as the square of the distance increases. He also treats of electrical attraction generally, and likewise says in the sixth lecture, "I have heard that lightning, striking upon the mariner's compass, will sometimes turn it round and often make it stand the contrary way, or with the north pole towards the south."

A. D. 1772.——Mesmer (Friedrich Anton), an Austrian physician, who, upon taking his diploma at Vienna, in 1766, had published a thesis "On the influence of the planets upon the human body," begins his investigations as to the power of the magnet with the steel plates of Father Hell. The results proved so favorable that the latter soon published an account of them, but he incurred the displeasure of his friend by attributing the cures merely to the *form* of the plates.

Mesmer, however, subsequently found out that the magnet was incapable, by itself, of so acting upon the nerves as to produce the results obtained and that another principle was involved; but he did not give an explanation of it and managed to keep his process a secret for quite a while. He had observed that nearly all substances can be magnetized by the touch, and he soon announced his abandonment of the use of the magnet and of electricity in his production of what became known as *mesmerism*.

In 1779 he published his "Mémoire sur la découverte du magnétisme animal," in which he says: "I had maintained that the heavenly spheres possessed a direct power on all of the constituent principles of animated bodies, particularly on the *nervous system*, by the agency of an all-penetrating fluid. I determined this action by the intension and the remission of the properties of matter and organized bodies, such as gravity, cohesion, elasticity, irritability and electricity. I supported this doctrine by various examples of periodical revolutions; and I named that property of the animal matter which renders it susceptible to the action of celestial and earthly bodies, animal magnetism. A further consideration of the subject led me to the conviction that there does exist in nature a universal principle, which, independently of ourselves, performs all that we vaguely attribute to nature or to art."

The whole theory and practice of mesmerism was, however, openly rejected by one of Mesmer's most capable pupils, Claude Louis Berthollet (1748-1822), a very distinguished French chemical philosopher, founder of the 'Société Chimique d'Arcueil," and who, in conjunction with Lavoisier (A. D. 1781), Guyton de Morveau(A. D. 1771), and Fourcroy (A. D. 1801), planned the new philosophical nomenclature which has since proved of such service to chemical science. (See "La Grande Encycl.," tome VI., p. 449; "Biog. Universelle," tome IV., pp. 141-149).

Mesmer gave all his manuscripts to Dr. Wolfart, of Berlin, who published in 1814, "Mesmerism. . . as the general curative of mankind." And it was one of Mesmer's students, le Marquis de Puysegur, who discovered magnetic somnambulism, an entirely new phenomenon in animal magnetism. See the article "Somnambulism" in the "Encyl. Britannica," as well as the numerous works therein quoted, relating to the above named subjects, notably Mesmer's own "Précis historique des faits relatifs au magnétisme animal, jusques en Avril, 1781."

See, also, "Bulletin de l'Acad. de Méd.," Paris, 1837, tome I., p. 343, etc., and tome II., p. 370; Blavatsky, "Isis Unveiled," vol. I., p. 172, etc.; the report of Dr. Franklin and other Commissioners. . . against mesmerism, translated by Dr. William Bache, London, 1785; J. C. Schäffer, "Abhandlung, etc.," and "Kräfte, etc." (1776), "Fernere, etc." (1777), also "Journal Encyclopédique" for March, 1777; Van Swinden, "Recueil, etc.," La Haye, 1784, vol. II., pages 373–446; C. H. Wilkinson "Elements of Galvanism, etc.," chapter XVIII.; Champignon, "Etudes Physiques, etc.," Paris, 1843; "Archives du Magn. Animal," published by M. Le Baron d' Hénin de Cavillers, Paris, 1820-1823; Report on Animal Magnetism made by Charles Poyen Saint Sauveur, 1836; Du Potet's "Manuel, etc.," Paris, 1868; Hale's "Franklin in France," 1888, part II., chap. V., alluding to an interesting manuscript of T. Auguste Thouret now in the collection of the American Philosophical Society.

A. D. 1772.——Henley (William T.), F. R. S., invents the quadrant electrometer, an apparatus with which the quantity of electricity accumulated in a jar or battery is measured through the amount of repulsion produced by the fluid upon a pith ball suspended from the centre of a graduated arc. It is most generally attached to the prime conductor to measure the state of action of the electrical machine.

He is also the inventor of the *universal discharger*, for directing the charge of jars or batteries.

In the *Philosophical Transactions* for 1774, Henley and Nairne give an account of many curious experiments proving the superiority of points over balls as conductors. The same is shown by Swift in the *Phil. Trans.*, vol. LXVIII., p. 155. Henley also states that the vapor of water is a conductor of electricity; that when the flame of a candle is introduced into the circuit and a Leyden jar is discharged through it, the flame always inclines toward the negative side. He proves that electricity cannot effect a passage through glass. (*Phil. Trans.*, vol. LXVIII, p. 1,049.) He likewise makes a number of experiments to determine the relative conducting power of the different metals by the quantity of a wire of each of a given size melted by equal electrical shocks passed through them, and finds the metals, as conductors, to hold the order following: gold, brass, copper silvered, silver, iron. It was also shown by Nairne that copper conducts better than iron, in the *Phil. Trans.* for 1780, vol. LXX., p. 334.

See Harris, "Rud. Electricity," 1853, p. 93, and his "Frictional Electricity," 1867, p. 23; *Phil. Trans.*, 1772, p. 137, and 1774, p. 133; *Transactions of the Humane Society*, vol. I., p. 63.

A. D. 1772.——Cavendish (Henry), F. R. S., younger son of Lord Charles Cavendish, and a prominent English scientist, sometimes called "The Newton of Chemistry," commences investigating the phenomena of electricity, in which he greatly distinguished himself and the results of which were duly communicated to the *Philosophical Transactions*. His papers contain the first distinct statement of the difference between common and animal electricity and embrace twenty-seven mathematical propositions upon the action of the electric fluid.

Cavendish made many very accurate experiments upon the relative conducting power of different substances. He found that electricity experiences as much resistance in passing through a column of water one inch long as it does in passing through an iron wire of the same diameter four hundred million inches long, whence he concludes that rain or distilled water conducts four hundred million times more than iron wire. He also finds that a solution of one part of salt in one part of water conducts a hundred times better, and that a saturated solution of sea-salt conducts seven hundred and twenty times better than fresh water.

By means of the electric spark he decomposed atmospheric air. He likewise successfully demonstrated the formation of nitric acid by exploding a combination of seven measures of oxygen with three of nitrogen. This he did on the 6th of December, 1787, with the assistance of Mr. Gilpin, in presence of the English Royal Society.

He improved upon Priestley's experiments by studying and fully explaining the power of electricity as a chemical agent. In one of his experiments he fired five hundred thousand measures of hydrogen with about two and a half times that quantity of atmospheric air, and having by this means obtained 135 grains of pure water, he was led to the conclusion, which Mr. Watt had previously maintained, that water is composed of two gases, viz., oxygen and hydrogen.

He shows why no spark is given by the electrical fishes. The latter may contain sufficient electricity to give a shock without being able to make it traverse such a space of air as is necessary for the production of a spark, for the distance through which the spark flies is inversely (or rather in a greater proportion) as the square root of the number of jars in operation. For an account of his experiments anticipating Faraday's discovery of the specific inductive capacity of various substances, see chap. XI., pp. 69–142 of Gordon's "Physical Treatise, etc.," London, 1883. See, likewise, J. Clerk Maxwell's "Electrical Researches, etc.," Cambridge, 1879, pp. liii. to lvi., as well as references therein made—more particularly, at articles Nos. 355 to 366, 376 (note No. 27 at page 432), 523, 526—to *Phil. Trans.*, vol. 167 (1877), p. 599, and to Spark's edition of Franklin's "Works," vol. V., p. 201.

See Dr. G. Wilson's "Life and Works of Hon. Henry Cavendish"; Sturgeon's *Annals*, vol. VI., pp. 137, 173, etc.; Noad, "Manual, etc.," pp. 14, 161; Harris, "Electricity," pp. 136, 140; Harris, "Frictional Electricity," pp. 23 and 45; Whewell, "Hist. of the Ind. Sciences," 1859, vol. II., pp. 203–206, 273–275, 278; C. R. Weld, "Hist. Roy. Soc.," for Lord Charles Cavendish, vol. II., pp. 171, 176–185, 221; Thomas Thomson, "Hist. Roy. Soc.," London, 1812, pp. 456, 457, 471; Sir William Thomson's "Works," 1872, pp. 34, 235; *Phil. Trans.* for 1776, vol. LXVI., p. 196; Thos. Young, "Lectures," 1807, vol. I., pp. 658, 664, 751, and vol. II., p. 418.

A. D., 1773.——Walsh (John), F. R. S., demonstrates the correctness of Dr. Bancroft's opinion that the shock of the *torpedo* is of an electrical nature, resembling the discharge from a Leyden jar. In the letter announcing the fact, which he addressed to Franklin, then in London, he says: "He, who predicted and showed that electricity wings the formidable bolt of the atmosphere, will hear with attention that in the deep it speeds a humbler bolt, silent and invisible; he, who analyzed the electric phial, will hear with pleasure that its laws prevail in *animated* phials; he, who by reason became an electrician, will hear with reverence of an instructive electrician gifted at its birth with a wonderful apparatus, and with skill to use it."

Mr. Walsh's experiments were made off Leghorn, in company with Dr. Drummond, as stated in *Phil. Trans.*, 1775, p. 1, and were confirmed by Johan Ingen-houz as well as by the Italian naturalist, Lazaro Spallanzini. The last named found the *torpedo* shocks strongest when it lay upon glass, and that when the animal was dying the shocks were not given at intervals but resembled a continual battery of small shocks: 316 of them having been felt in seven minutes.

See Leithead, "Electricity," p. 135; Gray, "Elements of Natural Philosophy," 1850, p. 323; "Electrical Researches of Lord Cavendish," 1879, pp. xxxv., xxxvi. and 395–437; Fifth Dissertation of "Ency. Britannica"; *Phil. Trans.*, for 1773, 1774, 1775 and 1776; "Chambers' Encyc.," 1868, vol. III., p. 821; "People's Cyclopædia," vol. I., p. 628; Kaempfer (A. D. 1702); *Sc. American Supplement*, No. 457, pp. 7,300, 7,301; "Letter adell' Abate Spalanzani al Signore Marchese Lucchesini," Feb. 23, 1783, inserted in the *Gothaische Gelehrte Zeitungen* for 1783, p. 409. See, also, the experiments of Dr. Ingram, of Kaempfer and of Bovelli, described in Van Swinden's "Recueil, etc.," La Haye, 1784, vol. II.; Wilkinson's "Galvanism," 1804, vol. I., pp. 318, 324; G. W. Schilling, "Diatribe de morbo, etc.," 1770, and Friedrich von Hahn in the preface to Schilling's "De Lepra, etc.," 1778, as at pp. 436–442, vol. I., and at note p. 160, vol. II., of Van Swinden's "Recueil," already noted; J. B. Leroy and M. Saignette "Sur l'élect. de la Torpille, etc." (*Jour. de Phys.* 1774, vol. IV., and for 1776, vol. VIII.)

Continued from The Electrical World, Sept. 12, 1891.

Proceedings of the Fourteenth Convention of the National Electric Light Association.

FIRST SESSION.

The National Electric Light Association began its fourteenth convention at the Windsor Hotel, Montreal, Sept. 7, 1891. The President, Mr. C. R. Huntley, of Buffalo, N. Y., took the Chair at 3 o'clock P. M., and said:—Gentlemen: It affords me great pleasure in opening this, the fourteenth convention of the National Electric Light Association, to have the honor of presenting to you the chairman of the Citizens' Executive Committee of the city of Montreal. I introduce to you Prof. Bovey, of McGill University.

Prof. BOVEY: Mr. President, officers and members of the National Electric Light Association of the United States—It devolves upon me as president of the Citizens' Executive Committee to offer you a very hearty welcome. It is no little pleasure to have this opportunity of meeting and making the acquaintance of so many of the foremost promoters of electrical science. We sincerely hope that this convention will be full both of instruction and enjoyment. We feel sure of the instruction, as that depends upon you; as to the enjoyment we trust that the entertainments provided in the programme will prove agreeable diversions. Gentlemen, I again wish you a hearty welcome. I have now the honor of calling upon His Worship the Mayor of Montreal, the Hon. James McShane, who will now address you.

Mayor MCSHANE: Mr. President, ladies and gentlemen—When my friend Mr. Bovey, who just sat down, said that he would introduce me to the audience, and that I would make an address, I think he made a misstatement; I am here as the Mayor of Montreal, and I have but a few words to say to you. Some few months ago Mr. Corriveau, a native of the city of Montreal, a French Canadian, called upon me one day at the City Hall and asked me as Mayor of the city if I would in my own way endeavor to give him some encouragement to ask your body to make Montreal your next place of meeting. At that time I gave him a letter, and I believe that Mr. Corriveau has done his part well. I know that there was opposition, and I think that St. Louis, and other places in the United States had sought to take you there, but Montreal has succeeded in bringing you here, and now in the name of the citizens of Montreal I offer you a hearty and sincere welcome. I am sure that the citizens of Montreal will do what they can to make your stay while here as pleasant and agreeable as possible. I am not going to speak of the great good that your association has done and will do in the future, because there are some gentlemen upon this platform—gentlemen who are a credit to any country from which they may come—who will speak to you upon that subject. But I can assure you that if I understood all the facts I might make a humble effort to say something to you upon the question, but I would sink into insignificance when you hear the gentlemen who are to come after me, and who will speak to you upon the great subject which you are here to consider. Therefore I will just content myself by saying to you again that you are most welcome among us, and that the people of the city of Montreal will do all that they can to make your stay with us as agreeable as possible.

Prof. BOVEY: Mr. President, I now call upon Sir Donald A. Smith to say a few words.

Sir DONALD A. SMITH: Mr. President, officers and members of the National Electric Light Association, ladies and gentlemen—You have already heard words of welcome from the president of the Citizens' Committee, and also from His Worship, the Mayor of Montreal, spoken in more appropriate terms than it would be possible for me to use. My own words are not required to give you a hearty welcome, but I do assure you, for my fellow citizens and for myself, that we are delighted to have you with us, and that it gives us the greatest satisfaction to find that you have honored us by coming here on this occasion. I do assure you that we appreciate very highly having you among us. Nothing can be of more benefit, nothing can tend more to induce cordiality among the peoples of one nation and another than such conventions, such comings together, such communings as we are to have here on this occasion. We hear occasionally of such things as a union, and there may be different views as to whether it may be beneficial or otherwise. I have no doubt there are such in the United States, and also in this country. But, be that as it may, I am one of those who believe that a coming together as on this occasion of the peoples of different countries, and especially those who are neighbors together, as we are, and have such constant and such great relations with each other in trade and in every respect, cannot but clear away many of those cobwebs and many of those ideas which we have had each of the other, and which were entirely erroneous. And I am sure that the welcome which you will have here from the people of Montreal will be as sincere, as earnest, and as cordial as it would be possible that any welcome could be. As we shall have the pleasure of meeting again this evening, I believe I may then be with you to see the great advance that has been made in this science of electricity, to see how by the power of man it can be controlled, and that although when left to itself it is capable of doing injury such as we cannot calculate, yet when under proper restrictions it is capable of almost turning the world upside down in everything that is for the benefit of mankind, even so should we in welcoming such gentlemen as you, sir, and those who have come here, not only to interest, but to instruct us; and I will only again, before sitting down, say that you have a most cordial welcome from the citizens of Montreal, and that we only wish to know how we can make pleasant to you in the best way in our power your visit among us on this occasion. But before sitting down I would say that we have had communications from His Excellency the Governor-General of the Dominion, Lord Stanley, which express very great regret at being unable to be here to join in doing honor to you to-day, on this occasion and this evening, but he has made a point of arranging his engagements so that we shall hope for his presence at the banquet which our citizens will have the honor of tendering to you on Thursday.

Prof. BOVEY: Mr. President, I have now the great pleasure of calling on Sir J. W. Dawson, the principal of the McGill University.

Sir J. W. DAWSON: Mr. President, ladies and gentlemen of this association—In tendering you a cordial welcome not only from McGill University, but I think I may say also from all teaching bodies in the Dominion of Canada that are interested in the practical and applied sciences, I only recognize what now all of our universities and colleges are bound to recognize—that in the presence of an association like this we are in the presence of the representatives of a great and growing profession, and one which more than perhaps any other has served to bring to the notice of the world the great advantages that may arise from the prosecution of the physical sciences. Your science was prosecuted for a long time before much was known of its practical applications, but in the present day, as you know, and in the last few years this great subject of practical and applied electricity has not only come to be something wonderful in the growth which it has presented in regard to its own special developments in telegraphy, in lighting, and in other matters of that kind, but also because it has been, young though it is, lending a hand to older scientific professions. We find now that the civil engineer, the mechanical engineer, the mining engineer, the metallurgist and the assayist, all of them, are under obligations to the electrical engineer, and it is now extending its hand—this young giant which has grown up among us—to all the older branches of our scientific professions, and it is making more than ever before the subject of the physical sciences one which is attracting the attention of the community, and young men are endeavoring more and more to qualify themselves to enter professions of this kind. That gives us in our university a good reason and gives all universities everywhere a good reason for recognizing such an association as this by offering it a cordial welcome—and this we in McGill University are entitled to do the more especially on this occasion because you honor our academical town with your presence. That we consider to be a great honor, and not only so, but you come at a time when we in McGill University are expecting, at the next session, through the liberality of one of our great benefactors here in Montreal, to be able to establish for the first time in a thorough and efficient manner a course of electrical engineering, and in which we hope to have many of our young Canadians emulate the skill and success which you, gentlemen, and others on the other side of the line, have so eminently shown in this great and rising profession. And so, in behalf of McGill University, and I may say in behalf of all educational interests in Canada, I have the greatest pleasure in offering you a kindly welcome, and in saying that we shall do all that we can to make your stay here as pleasant and profitable as possible.

Prof. BOVEY: I will now call upon Alderman William Clendinning to say a few words.

Alderman CLENDINNING: Mr. President, ladies and gentlemen—A hearty welcome has been tendered to you by the leading men of our city—His Worship, the Mayor, the president of our great educational institution, and by other gentlemen—and it remains merely for me, as an alderman, in behalf of the aldermen, to tender you a most hearty welcome. I need not say that Montreal feels especially honored by your presence. I think when it is borne in mind that the great cities of your own country competed for the honor of your session, and that you gave Montreal your preference, Montreal ought to feel specially proud of your coming; and I say in behalf of the aldermen, and also in so far as I may speak in behalf of my fellow citizens, that I think that nothing will be left undone to make your stay among us as pleasant as it can be. You represent a science which has changed the entire face of the commercial world. There is probably nothing that has contributed so largely in this respect within the last century, or that has so changed the entire condition of things in the commercial world, as has electricity. I think that you gentlemen on the other side of the line have astonished the world with the usefulness that you have proved can be brought out of electricity. I am sure that you have but just opened the door, and I do not think that anybody can tell what is going to come in the future. I am sure that there are a great many more purposes that you are going to serve in the near future. I wish you all success, and I tender you a very hearty welcome.

Prof. BOVEY: I have the pleasure of calling upon the honorable Justice Wurtele.

Mr. Justice WURTELE: I can only say that I repeat the welcome that has been already extended to you. I did not expect to be called upon to make any remarks. I merely came in because I thought that as many as possible of our citizens should turn out to do honor to this occasion.

Prof. BOVEY: I have much pleasure in calling upon Ex-Mayor Beaugrand, of the city of Montreal, and one of our old French-Canadians.

Ex-Mayor BEAUGRAND: Mr. Chairman, ladies and gentlemen—I really do not know that I have much to add to what has been said. So much of welcome has been already tendered you that nothing is left to me to say upon the subject were it not that I probably represent here the French element. I presume that you are aware that the city of Montreal, with a population of two hundred and fifty thousand, has one hundred and fifty thousand French, which we call a majority at election time. I am sure that those who constitute the French population of Montreal are very happy to join their friends of other nationalities in tendering you a hearty welcome; and as far as the French are concerned I suppose that I do not need to recall to technical men like those who are present, that there are in the history of French science the names of such men as Jablochkoff, and others, who have done a few little things in electricity, and have done them in such a way that their services are recognized and appreciated by Frenchmen and Americans alike. This has been done in the past and I am sure it will be in the future. I am sure that on this occasion of your visit here you will meet none but smiling faces among the French-Canadians in the city of Montreal, and I assure you once more of their very hearty welcome, a welcome from all, irrespective of nationality. I doubt not that in your exhibition every citizen of Montreal will not only see, as Sir William Dawson has said, a very interesting exhibition, but many things that are very instructive, and that your presence here and your visit to our city will be the occasion of giving us great pleasure, and of teaching us things that we do not know quite so well as our brothers, the Americans—because they are practical men, who are applying the sciences so as to get money out of them, and their reputation is made in that way. As far as electricity is concerned, there is probably no country in the world that has gone so far as they have done. I have had occasion in traveling out West for the last few years to observe this, and wherever I have gone, even away out in the Rocky Mountains, I have found your appliances there, making money, lighting the cities, and advancing civilization. There is no doubt at the present moment that the great power of the future is electricity, and we are very happy to see here the vanguard of Americans who come to represent it in our city. We tender them a hearty welcome once more.

Prof. BOVEY: I will now introduce Alderman Cunningham.

Alderman CUNNINGHAM: Mr. Chairman and members of the National Electric Light Association, ladies and gentlemen—I can only indorse what has been said by the previous speakers, and what to my mind they have said so well. I am a very poor authority on electrical matters, notwithstanding I have sense enough to know that electricity will revolutionize our machinery, and that instead of horse power and steam power, electricity will be the motive power. As I said before, I am no authority on electricity, but perhaps I might say a few words of explanation as an alderman. I am pleased to know that this meeting takes place in our city, but as an alderman I am sorry to say that many of our streets are not in such a condition as we wish them to be. Yet, to our visiting friends I will say that they can see that we are doing a great deal in the way of permanent pavements, and that in a short time our city will be in keeping with modern cities. Ladies and gentlemen, when this meeting is over, and when it is a thing of the past, I hope you will have every reason to congratulate yourselves on having selected the city of Montreal for the meeting. And perhaps it might not be out of place if I was to say on behalf of the citizens that they owe a debt of gratitude and of thanks to the members connected immediately with this association (I mean Prof. Bovey, Mr. Corriveau and others) who have worked to bring this meeting here, and to make it a success. As far I am concerned, I will do all that I can in order to make your visit among us agreeable, and I hope that when you return to your homes you will carry with you pleasant recollections of the city of Montreal.

Prof. BOVEY: For the last address of welcome on the present occasion I will call upon Mr. Richard White.

Mr. WHITE: Really, Mr. Chairman, I can only say "ditto." So much has been said, and so well said, that I think that you would much sooner listen to the addresses of the members than to any further words of welcome. I do not think that I can add anything to what has been said, and I can only express my hearty sympathy and accord with the sentiments expressed by others.

President HUNTLEY: Mr. Chairman, ladies and gentlemen—For the first time in its history the National Electric Light Association meets on other than its native soil. Yet even in so doing it but adds new evidence to the feeling in the breast of every electrician that his art is foremost among the influences tending to promote human intercourse and break down the walls of separation. Coming, as do our members, from every State in the Union and the Dominion of Canada, and representatives as they are of all the varied agencies and methods for the distribution of electric light and power, it affords me the greatest pleasure to acknowledge in their name the fraternal welcome with which we have all been received, and the lavish hospitality that makes us at home

in this noble Dominion and in its magnificent city of Montreal. From the fact that the invitation was so cordial, and that the reception has been so warm, I can but infer that the association enjoys here an intelligent appreciation of its work, its object and its aims. Permit me to say, therefore, that the association asks for itself, during the coming week, a kindly tolerance of its technical papers and discussions, hoping that the large exhibit of electrical apparatus of the latest and most perfected character may make amends for the somewhat abstruse nature of its proceedings. If the earnest and practical quality of our dealing with the great questions of electricity shall in any wise stimulate electrical work in Canada and lead to the electrical utilization of its great water powers and coal beds in light, locomotion, power and heating, we trust that it will be accepted as at least some slight acknowledgment of the manner in which we have been so generously greeted. I have the honor of calling upon United States Consul General Knapp to say a few words to us in behalf of the United States.

Mr. Knapp: Mr. President and members of the National Electric Light Association, ladies and gentlemen—It affords me great pleasure to be present and participate in the exercises of this afternoon, and I am sure that you need no words from me, after those which have been uttered by the several gentlemen who reside in the city of Montreal, to assure you of a most hearty welcome, and I am certain that I can speak for the members of the National Electric Light Association in saying that should it ever be the lot of citizens of Montreal to visit their cities that they will give you a loyal and hearty greeting. But assume that it is with the gentlemen who have spoken from the city of Montreal, as it is with me, one of the best thoughts connected with your coming here that you have come in a most gallant way, that you have brought with you those we all like to see, the ladies, and so I will say for the city of Montreal and her citizens that they bid also a loyal and royal welcome to the ladies who come with this National Electric Light Association. The associations of this hour are suggestive of two-fold congratulation—first, congratulation to the city of Montreal that she has the privilege of having so royal a guest and one so worthy of her hospitality as this National Electric Light Association—an association which, although young in years, embraces in its membership men who have become famed in their works, men whose success in the great fields of science and invention have become the proud heritage of mankind—an association which has for its purpose the development of one of the grandest sciences known in this nineteenth century, a science which in its development and in its application is for our good, ministering to the wants of humanity and also ministering to the wants of nations. But while I congratulate the citizens of Montreal in having so royal a guest, I may also congratulate you who come from the United States in having a host so royal as is the city of Montreal. Let me say to you as visitors of my own nationality you will realize that it is a city justly famed, a city where mercantile and manufacturing industries tell the story of prosperity, a city made beautiful and interesting by historic spots, by noble monuments, by stately edifices. where churches of every denomination point toward Heaven their spires of faith, and where institutions of learning like the McGill College rise and shed their rays of light through this Dominion, to other nations and to the world. You will also find it a city whose citizens always have a hand of welcome, a word of greeting and a heart of friendship for the representatives and for the people of the United States. And so I say that this is an hour for mutual congratulations and felicitation, and as I join in them and in one sense bid you welcome; in another sense,if I may be permitted, I will express to the citizens of Montreal your gratitude for this royal greeting, and I beg to express the hope that as your stay will be pleasant, so your convention will be one of profit to you as individuals, and of advantage to the great science you represent, and through it all we shall realize, better than ever before, that we are all citizens of two countries, which are, and will continue to be royal friends.

The President: I have now the honor of introducing Judge Armstrong, of Camden, New Jersey.

ADDRESS OF JUDGE ARMSTRONG.

To you, Mr. Chairman, the chief Magistrate of this city, to this committee, who so kindly and so cordially bid our association welcome, I am called upon by the man that we have learned to obey, to respond. I can promise you in advance that the response that you will receive from every one wearing the ribbons will be much more cordial, much more appreciative, much more expressive than any words that I can use, because it will be an active gratitude. Mine is none the less sincere, none the less hearty, and as I have listened to these cordial words that came to us I realized again and more fully I think than ever before what electricity does. It has been called the great annihilator of space—that thing that reaches its destination as soon as it starts. It is evidenced here to-day that it can annihilate state lines, that with it no peoples are known—only one people; that no communities are known—only one great family. We, therefore, appreciate most heartily the welcome you have given. You have asked why we should leave the cities of the States where we peculiarly belong, it is claimed, and come here. Do you know who your representatives were that you sent down to invite us to come? If you do know them as we have learned to know them, you will know that we could not help coming. They promised us well, but we have already received much more han they ventured to promise. Had they told us what you have told us here to-day, we would have begun to suspect that their promises were too fair, the allurements were too great, and we would have been afraid to come. They just told us enough to induce us to come, and we are glad that we came. I would not dare, I suppose, across the line—I have heard you refer to some line here—I would not dare, I suppose, across the line to refer to the thing that Sir Donald Smith referred to, but I imagine I can venture to do it here, because I have understood since I have been here that there are no politics whatever in the Dominion. The McKinley Tariff bill was referred to, and I heard a great many ladies complaining when they were crossing that line; and I would like to say to them that the examination was not on account of the McKinley tariff.

I find that Montreal is all that has been claimed for it. I stood at that point and overlooked as fine a scene as ever my eyes beheld. It was indeed a royal view. Spread out before me was a scene of marvelous beauty. We saw the magnificent buildings, the great churches, the industrial establishments. We saw here and there the evidence of stupendous enterprise, and we learned that this was indeed a city of great progress and a place of great enterprise. But I was greatly surprised to find that you had not learned one thing over here so well as we could teach you across the line. I heard your ex-Mayor say, in speaking for the French Canadians, that 150,000 was a majority of 250,000. Now we can find many ward politicians down our way that can show you how that majority can easily be overcome. We do not count majorities in that line at all, and I am surprised, with all your enterprise, with all your advancements, that that is one thing that you have not grown on Canadian soil yet.

This welcome, though, my friends, that we have received—it seemed to me as I saw the earnest expressions on the faces and as I knew, as men can know, that these words came from the heart, I looked down here at this badge and I saw the two flags, distinct and separate, standing out clear, but under the button bearing our name there was some sort of connection, it was completed there. The flags stand distinct, and yet they meet at a common centre, they meet at a common point, they have a point of contact where they are all interested. They meet around this circle where there is no people known, no government known, only the good of mankind as mankind. And glad am I to meet in such an assembly—glad am I to take part in such a community. When such assemblies gather, when such communities meet, when such interests are brought together, then you may know that all the dickering of politicians, that all the selfish enterprise of sovereigns or sovereignties, that everything that may be done by individual ambition or individual avarice must give way to that thing that speaks so well for common humanity—that one enterprising feeling, that one desire, that one earnest hope to benefit the whole of the people of the world, and advance them all as one community. I therefore particularly appreciate the welcome—the Canadian welcome—that is given to this association. I particularly appreciate the fact that we are here assembled—and while I never mean to forget, nor do you want me to forget, that my allegiance is owed somewhere else—I am proud that upon this great continent there is a people of such enterprise, such energy and such ambition as I have been permitted to see in the few hours that I have been here. I rejoice with you, my friends upon this committee, on the promising future that you see for Canada. I rejoice because what does you good will do us good, what is good for us will be good for you, and what is good for you will be good for us. Our community of interest is great. I am glad that we can meet here with you, and I feel in the language of the German doctor whom I have heard speak at one of the International Medical Convention. He desired to express how he enjoyed being there. Seeing his own flag from his window he said it made him feel very homely, and the words that I have received from you here, and what I have seen floating over the hotel where we stop—the banner of our own country, seeing it over McGill College—seeing all these things, has made me feel very homely, and when one of your aldermen came out and after joining in the welcome began to apologize for your streets I felt entirely at home. We have been greatly libeled as a people, and will you permit me to make this inquiry? It is said that as Americans we want everything, and I am inclined to think that some of this committee may have had that same notion in mind when they came and extended this welcome, because they did not propose to leave anything to be asked for—they have given us the whole thing, and I only question in my mind whether or not it was because of the libel upon us as a people. I trust that that may not be so.

Now, one word more. One of the speakers congratulated us because we brought the ladies along with us. That proves conclusively that he has not been at our electrical conventions heretofore, and I am sorry to say that it proves that he does not know anything about the science of electricity. Ask any one of these bright young electrical engineers—and you will observe that most of these electrical engineers are young men—ask any of these engineers what he could do without an attachment. Ask him to tell you how necessary it is to have both positive and negative currents and ask him also about the essential character of a switch. Ask him about any of these things and then never again will it be noted as a matter of mark that ladies are attending electrical conventions.

I speak not merely formally when I say to Your Worship, to the chairman of this committee, to this committee and through them to the citizens of Montreal, I speak not merely formal words when I say that in our hearts we deeply appreciate this welcome. A more cordial welcome this association has never received; a more hearty reception has never been given, and coming to this place at this time and under these circumstances, we deeply appreciate it. We have gone about your beautiful city, and I want to say right here that I went to 10 churches yesterday, and I understand I have got 66 yet to visit. As we go about your beautiful city and see the good that you have here, and see the enterprise that you have here, and see the works of beneficence and benevolence that have been inaugurated here—as we see all these things and receive such warm words, such hearty greetings as you have brought to us, we promise you that in so far as in us lies we shall make this convention the banner convention in the history of the National Electric Light Association.

The President: I have the pleasure of introducing one who, I think, is not wholly unknown to you—Mr. Erastus Wiman, of Staten Island, New York.

ADDRESS OF ERASTUS WIMAN.

Mr. President, ladies and gentleman—I could not resist the temptation to spend a few hours in Montreal, to act in a double capacity. A resident and a member of this association in New York, I wanted to come here and partake of the hospitality of the city in which I spent some of the happiest years of my life and in which perhaps I am better known than any man that ever left it. In another capacity I want to come as a Canadian and to say a few words of welcome to the men with whom I have been associated in the latter years of my life in the great country on the south—to say how glad we Canadians are to see you among us. There is nothing in the world that is so productive of good as the mingling of these two races together. If they met more often, if they understood each other better, if they comprehended the great good that is in both, better conditions would prevail, and a larger charity and a better trade and a greater progress would come in everything. But I come today in this double capacity simply to testify as I think no other Canadian can testify to the Canadians themselves what a marvelous brood of young fellows has sprung up in the last five years in connection with electrical engineering and electrical propulsion. It seems to me as if a new creation had dawned on the world. I want to say to my young Canadian friends what a beautiful thing it is to think that out of the great cities like Chicago, St. Louis, Boston, Providence, New York and all over there should come such a representative group as we have here to-day, so representative of the great growth of science—such wonderful achievements as they have been the instrumentalities of performing. I am glad to stand before you in this double capacity, first as a member of this association, to thank the gentlemen for the hospitalit y extended to us; and, secondly, as a Canadian, to thank you for coming to my native land. I think I can say to Americans here, that great as has been the progress of electricity in the United States, the Canadians have shown an appreciation of it greater almost than that of the people of the United States themselves. I doubt if any system in the world is more perfect than the system of telephones in Montreal and Toronto. I doubt if any city in the United States has such a development of that marvelous instrument as those two cities have. As to the telegraph service, somewhat connected with it as I am, I believe I may say this, that there is a larger mileage of wire, a greater number of offices and a greater number of messages transmitted in proportion to population in Canada than in any other country in the world. I can say this, too, that a lower rate—a cheaper price for transmission—is uniformly afforded in the Dominion of Canada than in any other country in the world, taking distance into consideration, so that in telephony and telegraphy, electricity has found on this continent, in this Canada of ours, its greatest development. I would like to say to Canadians, though, that in certain things in the United States a greater progress has been made than here, and that is one idea I had in asking to speak to you to-day—namely, that I should draw your attention to the marvelous growth in the United States of the use of electricity in the street railway. It seems to me that no one thing has grown with such rapidity as the value of real estate wherever there has been an electric railway introduced. I know that it is alleged that the United States have the power to create wealth greater than that of any other country. I know that last year we produced in that country eight millions of bales of cotton, which sold at a price of $400,000,000—a sum greater than all the gold mines in the world produced in five years. I know we mined ten million tons of iron, and I know we produced this year an enormous crop of wheat. These are great accumulations of wealth, but they sink into insignificance compared with the increased value in real estate wherever an electric railway is promoted. There has been a greater advance in Boston in the value of real estate by the establishment of the West End Railway than Boston ever made by any other influence. I saw in Minneapolis and St. Paul, those two wonderful rivals that we see struggling to get ahead of each other all the time, a greater growth in values and a more perfect system of communication than by any other means possible—so at Tacoma, so at Spokane. It is strange that in Montreal, of all cities in the world, that is only beginning to be realized. I want to impress Montreal and also other cities with the great advantage that comes from this marvelous method of propulsion. Still I want to impress on my friends in Canada the advantage that the electric system has in the transmission of power. I was in Boston on Friday and stood in one station which had a potential of 20,000 h. p.—a power so vast as almost to be beyond human conception. Fancy, if you can, 20,000 horses under one cover, saddled and bridled and ready for a start. Fancy the forces that were latent in that potential under that roof, and yet away off in some distant avenue, by some delicate wire, it was necessary only to touch the button and the power did the rest. So it would be in Montreal. It seems to me I do my duty as a former citizen of this place and still somewhat interested in it, in drawing the attention of the residents here to the fact that they possess the potentials of power almost beyond any city in the world. In the great rapids above them and below them are forces which, if applied by electricity, would be of the greatest advantage. I know of no city that has such enormous facilities for the creation of electricity as this city has. I know of no place in which power can be transmitted so perfectly and completely as in this city, so that a delicate wire running over a house might work a fan in a sickroom, and in the next block might lift a triphammer; so that a sewing machine, or a half a dozen of them, or fifty of them, or a factory, could be run from the St. Lawrence and Ottawa by the transmission of this power.

An optician might grind the most delicate piece of glass in a small lathe before him, and even the running of a sewing machine and the rocking of a cradle might all be done by electricity. I think I can see in the marvelous growth of that power that the fecundity of the French race will be even increased by the facility of rocking the cradle by electricity. Perhaps when that day comes the success will tell a different tale. I hope it will. At any rate we want something to stimulate this country to grow a little faster. I have great gratification, indeed, in believing that you will have a most joyful time. So far as the city itself is concerned, I have the belief that your presence here will stimulate and draw attention to this question of not only having every street equipped with electric railroads, but making every ripple on the rapids contribute to the wealth of the city. I cannot but think that the great progress that electricity has made, and your presence here, will bring popular thought and popular opinion to bear on this question of the use of this tremendous force that lies now idle, so far as its transmission is concerned. If that should occur, it would all be attributable to the fact that the National Electric Light Association held its meeting in the city of Montreal. Montreal has facilities for manufacturing greater than any other city in the world. It has got raw material at its hand. It has got the cheapest and the best labor. It needs only the touch of electricity to make it the greatest city and the greatest country under the sun.

Pres. C. R. Huntley then delivered the following address:

ADDRESS OF PRESIDENT HUNTLEY.

My predecessors in this chair have seen the association advance in strength and worth, outliving trials and vicissitudes to emerge on a wider, larger field of usefulness and opportunity. I do not believe that there is another industry in the world which has passed through such quick stages of evolution as ours and become so soon established in popular favor and general prosperity. But we must not assume that because electric lighting has set its feet upon the rock and laid its deep foundations nothing more remains to be done save to pursue the policy and practice of the past. On the contrary, I deem it necessary to say here that my own responsibilities as a central station manager compel me, as never before, to be watchful of the tendency of conditions and inventions in the art, so that I may in any degree profit from my own hard won experience. If, as central station men, we are to secure adequate return on the investment committed to our care, it becomes us in every way to study closely all the ideas that will give higher efficiency of plant and higher economy in operation. There was a time when some of us expected to grow rich out of abnormal prices. To-day there is not one of us who does not know that his hopes of dividend lie wholly in the skill with which the best business ability and the soundest engineering are applied to the work in hand.

I take it that it is now pretty well recognized among intelligent station managers that the day has passed when they can limit themselves to one class of service or apparatus to the exclusion of all others. To obtain the fullest measure of success and the largest return from the capital invested, they must be ready to supply any demand made upon them. As a result, the successful station, even to-day, is gradually assuming a composite character. This compositeness is manifesting itself first in the variety of apparatus, as a result of the selection of the machines best adapted to a given class of work, and independent of any particular system. One cannot help seeing in this change from early practice a step toward increased efficiency of station operation, as well as a good reactive effect upon the manufacturers of apparatus, who are thus all placed on a common basis of competition. But besides a compositeness in detail, signs are not wanting that no one method of distribution from a central station can, in the large majority of cases, be adequate to the demands that are made upon us, and that to meet them in a manner to insure a profitable business requires a flexibility and variety in methods of distribution, the full extent of which is to-day hardly recognized. To reach the full limit of its usefulness, the central station should avail itself of methods which, I believe, will finally resolve themselves into what may be called the "zone system" of distribution.

The idea embodied in this zone system can best be explained, perhaps, by taking a concrete, practical example, and for this purpose the present occasion makes the city of Montreal an interesting one. Setting aside for the moment the possibility and even the probability of the transmission of electrical energy to the city from the power obtained at the Lachine Rapids, we will assume a station erected at the water front of the harbor, as indicated on my diagram. It will, I believe, be granted that up to within a distance of one-third mile radius the three-wire low tension direct current system of distribution answers fully every requirement of simplicity and economy, and hence if, with the station as a centre, we draw a circle having a radius of one-third mile, we shall have a "zone" supplied in the most economical manner for every class of light and power apparatus now familiar to us.

Coming to the districts beyond the first zone, we are necessarily obliged to have recourse to higher potentials for the feeders, and the selection of the proper potential is a matter of simple calculation. We may, for the sake of this argument, call it 500 volts. Continuing on in this way, in steps of 500 volts, successive zones, half a mile across, might extend in the aggregate to several miles without reaching the limit of potentials which have been found to be perfectly feasible in practice.

In the example no reference has been made to the nature of the current employed or to the method of local distribution. Evidently we may readily resort to the alternating system, employing converters to reduce or raise the potential, or to the direct current reduced from high to low by motor dynamos. Either one is perfectly practicable. Perhaps some of our new school of electrical engineers will show us how to use the same circuits for both alternating and direct currents.

But, whatever system be employed, I deem it proper to record here my conviction that the most economical way to distribute the current to the consumers at the point of delivery is by low pressure conductors, in contradistinction to the plan now generally in vogue of giving each customer a converter of his own, or, in the direct system, a separate motor dynamo. I need not here enlarge upon the train of reasoning which has led me to this conclusion, but I may remark that I am strengthened therein by my own experience in Buffalo, where we are now introducing gradually 200-light converters and replacing the smaller ones heretofore employed. Nor do we propose to stop there, but expect to install converters of still higher capacity, distributing the current to a number of customers by low pressure mains centering at the large converters. As addressing myself to practical men I need not refer to the fact that it costs practically no more labor, etc., to put up a 200-light converter than it does a 10 lighter, while the initial cost per light is less in the case of the larger converter. In these conclusions I am only recommending for large commercial areas, what, I believe, is now recognized abroad by Ferranti and others, whose work like our own, will eventually lead to the establishment of large converter sub-stations from which low tension wires will supply the surrounding districts.

The allusion made to the motor-dynamo system for converting the direct current from high to low potential may to some appear nothing more than the citing of a possible method, in view of the existence of the alternating system, well tried and ready at hand. But without wishing in the least to detract from the merits of this system, which has probably done more to popularize electricity than any other, I cannot, as a practical man, conceal from myself the fact that, taking everything into consideration, the low tension direct current system of distribution is the most flexible within its area and serves the greatest variety of purposes. I do not think that any one can successfully contradict the assertion that to-day no other system can, with equal efficiency, take care of arc and incandescent lamps, motors, large and small, storage batteries, electric heaters, etc.

In making this statement I desire to be understood as referring to the present condition of the art, the only condition which, as practical men, we ought to consider in matters of this kind; but I hope the time will soon come when the same can be said of the alternating system. There are still other methods which suggest themselves by which the "zone" system could be effectually carried out, but those indicated are sufficient to demonstrate the idea I have endeavored to convey.

After the intelligent station manager has decided upon the nature of his apparatus and the initial capacity of his station, his most important consideration is the allowance to be made for future growth. Look back, some of you, and recall the mistakes made, but which were brought about by the enormously rapid growth of the industry. I need not go out of my own experience for such an example. Less than two and a half years ago we erected in Buffalo a new station considered far too large for even the most extended future growth. Some of my colleagues shook their heads. Yet even to-day it is being worked to its fullest capacity, and provision will soon have to be made for more facilities.

What then, may be asked, shall we determine upon as the unit time limit of growth for which provision should be made? Shall we build our stations sufficiently large to take care of the demands of five, or ten, or twenty years hence? This is a most serious question, and one, to my mind, as important as the selection of the proper station apparatus itself. I note the erection of several stations abroad, and some here, designed to supply the demands of 15 or 20 years hence. Without wishing in any way to detract from the laudable enterprise and faith exhibited by the promoters of these stations, a calm survey of the past, present and probably future condition of the art leads me to believe that the setting of so long a time limit as 15 or 20 years is inadvisable. I need not remind you in detail of the changes in methods and apparatus which have been effected during the last five years, by which the efficiency and output of our stations has been increased; and if to this we add the fact that already new methods, such as those pointed out by Mr. Tesla, may at any time increase the present lamp capacity of our stations five and ten fold, I think we may be justified in placing five years as the limit of time, to make provision beyond which may involve expenditures, the benefits of which may not be realized.

These are matters we are endeavoring to settle for ourselves. It is to our interest to settle them. So, too, with the underground question, but there we have gratuitous advice, assistance and abuse to such an extent that less progress is made than in any other part of the work. We all want to put our wires under ground, where the number is so great as to make them unsightly or unwieldly, and not a few of us have been parties to experiments now written off to profit and loss. As soon as the time arrives when every house has its wiring as a matter of course, just as now it has piping for water and gas, it will be a comparatively easy matter to lay down comprehensive underground systems. But at the present time the customers for current are scattered and not continuous. The man with enterprise enough to take electric light and power soon moves into a larger store. His successor does not want the service, but gropes along with kerosene or spoils his goods with gas. Cutting out disused underground services is an added risk and expense, and 10 lights could be installed on overhead circuits for $10 where with underground the cost would be $50. It follows that in any city—Buffalo, for example—we shall not make one underground connection where with overhead wires we would have made twenty. Now, are the public or are we the greatest losers? The public, I think. It is as unreasonable in most instances to demand underground wires as it is to expect every railroad to make every crossing above or below grade. But for our overhead wires, America would not be to-day the great land that it is of electrical triumphs; and, while I hail with delight every advance in the solution of the underground problem, I hope long to gladden my eyes with the sight of a pole well set and a wire well strung.

Another stirring question of the hour is that of municipal ownership. Now, it has been taken for granted that electric light men are against this plan, tooth and nail. How absurd that notion is. Because we represent the latest development of invention and industry, we certainly do not forfeit our pride as citizens, nor lose our interest in the advance of social science. It would, in fact, be difficult to find a more progressive, well-known body of men in America to-day than they who have put their money and energies into electric lighting. They are neither crusted or cranky, but when any movement has been started for the betterment of the communities in which they live, some of them have been at its head. Now, is it strange that such men should object to the confiscation of the properties they have built up and that are beginning to pay? Is it strange that they should ask for these new theories in social economy to be tried on something else first? Many of them have grave doubts as to the accuracy of the figures that are supposed to prove that municipal plants pay. Others of us have great objection to any taxation, the proceeds of which are to set the municipality up in a commercial business; others, again, believe that the best results are reached in any industry when it is freest from political influences and is left to the uplifting and perfecting impulses of individual enterprise.

I believe that the most conclusive answer we can make to the sophisticated arguments of an ill-disguised socialism presenting itself in this municipal ownership scheme is to give the very best service possible at the lowest rates compatible with fair profit. Some of the prices we now obtain are so low as to exclude any profit at all, especially when repairs and reconstruction are considered. But here again we may help ourselves out by native wit. Every company in the ranks of this association ought to ascertain for itself at regular intervals just how it stands as an industry. A good deal of apparatus in use is decidedly inefficient. Overhaul it. If necessary, throw it out and put in better. Above all, adopt a good system of book-keeping. It has been a source of much gratification to me to see in the pages of one of the leading electrical journals, recently, a most valuable series of articles on central station management and finance by Mr. H. A. Foster. I trust that every electric light man will read those articles, if indeed he has not done so already. The subject is admirably treated from the practical standpoint, and it is impossible not to derive good from the many hints and suggestions, while the various forms and blanks shown may be adopted with much benefit. Electric light securities are to-day far from enjoying the esteem in financial circles that they deserve. This is due in a measure to speculative investment and to over-capitalization in the past. But it is also attributable very often to the poor system of accounts employed, and I am glad to see the subject thus receiving attention. If we know what our current costs, we know what we can sell it for, and unless that information is obtainable from our office books, engineering will go for naught, and capital required for new work will stand aloof.

In conclusion I would urge that the association determine upon meeting only once a year. Even if it were not impossible to recover in six months from such overwhelming hospitality as we are now the recipients of, I believe that the time has gone by when half-yearly meetings were necessary. Once in twelve months is often enough for us to come together for the comparison of our experience, and the report of further refinements in the detail of the industry. The mere fact that frequent reunions are no longer necessary is in itself a hopeful sign, for it tells of stable and settled conditions and of activities that now require our presence at home pretty well the year round.

Gentlemen, I thank you for your attention, and I trust that your deliberations in the coming week will be characterized by the same earnestness which has characterized them in the past.

The president then read an invitation from McGill University to the members to visit the library, museum and buildings of the university; invitations from the Art Association of Montreal, to visit their gallery; and an invitation from the Quebec and Levis Electric Light Company to visit its works at Montmorency Falls; an invitation for a trip up the Richelieu River; an invitation from the Harbor Commissioners, to join them in a trip through the Lachine Rapids. The president added that there were also several garden parties, which had been announced, and which were printed in souvenir, and which would appear upon the daily bulletins.

On motion of Mr. Seely, the invitations were received and filed, and a vote of thanks extended.

The PRESIDENT: When the invitations were sent out, knowing that we would come to Montreal, the Executive Committee instructed its secretary to invite as a body the American Institute of Electrical Engineers, the New York Electrical Society, and the Electrical Engineers of Brooklyn. I have their response here, and the invitation has been accepted.

We are also in receipt of a letter from the Director General of the World's Fair authorizing Mr. Hornsby to represent them here in connection with the fair. I believe he will be here to-morrow and will present the subject to you when the matter of the World's Fair comes up, for which we have a committee. I wish to urge upon every member to be present at our meetings. We have many interesting papers and there is ample time for pleasure in the afternoon, and we should have every man, whether an associate or an active member, on the floor during the discussion, beginning at ten o'clock and lasting until two, and I hope that to-morrow morning and every other morning you will all be here.

As there was no further business to come before the meeting the convention then adjourned until Tuesday, Sept. 8, at 10 A. M.

SECOND SESSION.

The convention met for its second session at 10 A. M. on Thursday, Sept. 8.

The PRESIDENT: The first thing in order this morning will be the reading of the report of the Committee on the Relation between Manufacturing Companies and Central Stations, of which committee Judge Armstrong is chairman.

Mr. ARMSTRONG; Before reading the report of the Committee on Relation between Manufacturing Companies and Central Stations, I will with your permission present a letter from Mr. Shaw, of Eau Claire, Wis., sent me from the Special Committee appointed at the last convention on Amendments to the Constitution.

EAU CLAIRE, Wis., Sept. 3, 1891.

Mr. Chas. R. Huntley, Prest. National Electric Light Association, Montreal, Can.

DEAR SIR—The Special Committee on Revision of the Constitution appointed by yourself pursuant to a resolution adopted at the convention of the National Electric Light Association held in Providence, R. I., in February, 1891, has had under consideration the question of revision of the constitution, and beg to report as follows:

That in the opinion of the committee the fundamental features of the constitution and the general plan involved should not be modified or changed, and that while the constitution itself is susceptible of improvement in questions of detail, and, if intelligently amended, may be made more symmetrical, yet, as the constitution has not been in existence a sufficient length of time to give it a fair trial, it is our opinion that any changes, amendments or modifications at this time are undesirable, and we recommend that no amendments to the constitution be submitted at the forthcoming convention. Respectfully submitted,

GEO. B. SHAW,
E. A. ARMSTRONG,
Committee on Amendments to Constitution.

Mr. Shaw said that he was detained because of engagements over which he had no control, and could not be here. I move that this report be received, and the committee be discharged.

Mr. E. R. WEEKS: I second that motion, and with the permission of the Chair in so doing I want to say that I am very glad that this committee has reached this wise conclusion. I take it that that state, that corporation, that association that is continually dickering with its organic law is in a bad way, and that our constitution should be allowed to stand, at any rate until it has had that seasoning of time which will enable us to determine wherein changes are necessary. When the constitution of the United States of America was adopted you may remember of having read in history that various objections were raised to it. It was held even by some that under that constitution there would be nothing but ruin ahead for the States. But those croakers were not listened to, the constitution was given the seasoning of time that it required, and it was found that it needed but comparatively a few simple amendments. I have great pleasure in seconding the motion of Judge Armstrong.

The PRESIDENT: If there is no objection the report will be received.

Mr. Armstrong then read the following report:

The committee on Relations between Parent and Sub-Companies begs leave to report:

As this committee reported at the last convention so it reports to-day. No matter has been brought to its attention. One of its members asked yesterday, "What excuse can we give for previous existence or make for its continuance?" We have all realized the possibility of great good through this agency, but there has been but little attempt to utilize it. Unless something is to be accomplished in this field that demands the most thoughtful care and attention (and is the one point where our interests are to-day weakest) the committee ought not to be continued.

Very respectfully, E. A. ARMSTRONG,
E. R. WEEKS.

The PRESIDENT: You have heard the report of the Committee between Manufacturing Companies and Central Stations. What is your pleasure?

Mr. WEEKS: I move that the Committee on the Relation between Parent and Sub-Companies be instructed to formulate a definite plan of procedure for the protection of central station companies, and to prepare the necessary articles of agreement, and report the same to this association in executive session at its next convention.

Mr. FRANCISCO: I second the motion.

Mr. WEEKS: Mr. President, I fully and heartily concur in what was said by Judge Armstrong in regard to the importance of the work before this committee. In my opinion along the line of work in the mind of this association when this committee was appointed lies the salvation of the central station interests of America, and I think, Mr. President, that the time has come for some plain talk on this subject. I propose therefore to briefly read you the situation. You will remember that the early history of electric lighting was phenomenal in that the people were so ready to believe everything that was promised for the new industry, and so confident in its value as an investment. The wonderful achievements of Bell, Edison and others in telegraphy and telephony did much to pave the way for the introduction of the electric light. Such was the attitude of the public mind that companies were readily organized for central station work, and the extravagant statement of parent companies as to the performances of machinery, of their apparatus and of their manufacture were received with a cordiality not very complimentary to the wits of investors. Manufacturers of apparatus claimed for it a high efficiency, in one case even as high as 105 per cent. Declarations were made that with the exception of brushes and commutators, which might need renewing every two years, it was practically indestructible, nay, it was even held that it would improve with use, and they set their price so high on that that these qualities seemed assured. They guaranteed to purchasers: First, high efficiency; second, patent protection, and third, exclusive rights in their respective territories. They assured investors that the new light could be produced cheaper than gas, and, in order to compete with gas and increase the demand for the apparatus, they advised continual reductions in rates of service. Companies speedily organized in the larger cities, and capital smiled on electric light investments. It was soon found, however, that various so-called systems of electric lighting were extremely crowded, and the apparatus was so short lived that investments must be increased to meet the demands for improvemeat and for renewals, for which the parent companies made little if any discounts. Still, so confident were the local companies in success during future years and so blindly credulous in the good faith of manufacturers, that the additional capital flowed in and the parent companies were enabled to enlarge their producing powers and to increase their dividends. In the course of time it began to appear that the second claim of the parent companies, in consideration of which local companies had paid such high prices, could not be maintained. Patent protection was not given. The pioneer enterprises saw their field invaded by apparatus employing the very devices for which they had paid so liberally upon the assurance that those devices were controlled by the grantors. Meantime capital was beginning to discover that electric light investments were often bottomless abysses. The crude and imperfect apparatus, itself short lived, necessitated constant renewals, its extreme delicacy necessitated frequent costly repairs, and the cut-throat competition instigated and supported by rival manufacturers using practically the identical apparatus affected public confidence. Most of the profitable fields had been occupied and although the electric light had demonstrated its desirability, and its superiority over gas, the rate of service was necessarily much higher, owing to the greater cost of plant, operation and maintainance. As the parent companies found themselves with immense producing powers, and without sufficient demand to employ them, the very powerful ones began to purchase the business and factories of the weaker, presumably to clear the field of competitors, and the temptation to violate their contracts with pioneer local companies proved to be strong. It was observed with a few of these systems that their purchasers had placed them in charge of their most experienced men, and after fortifying their weak points by the use of their own special devices intended to sell this apparatus at greatly reduced prices in fields already fully occupied by their own apparatus, which had been bought at high prices by companies to whom they had promised protection of all kinds. What treachery can be more abominable for those who have borne the brunt of the new industry struggling for a foothold, who had literally enriched parent companies by their own pleading, who had created the demand for apparatus that patent companies had to sell, and who through their own experience had shown inventors and manufacturers wherein their apparatus could be improved and cheapened. But worse treachery followed. The most outspoken enemy of the electric light has always been gas. The gas companies were heavy corporations who had fully occupied the field of lighting for many years and had fattened upon the profits yielded by the industry of which they had a monopoly and which required a plant comparatively simple in construction, easily and cheaply operated and maintained, and employing raw material the residual products of which were made to yield a handsome revenue. When the electric light entered the field it labored under the enormous disadvantages of costly, complicated and imperfect apparatus, unknown operating expenses and depreciation and no by-products. Yet the gas interests, recognizing the new light as a formidable rival, fought it in every way available to a long established, powerful and wealthy monopoly. The parent electric companies were bitter in their denunciation of the methods employed by the gas interests in their efforts to prevent the establishment of the new industry, and until their revenues from local companies began to fail, assisted the latter in the struggle in every way which did not seriously affect their pockets. At the present time, Mr. President, the condition of affairs is changed. The gas interests are still opposed to the electric light. But as this has shown that it has come to stay, gas companies all over the world are preparing for a new effort. They will wage war with our weapons—with cheap apparatus furnished them by our parent companies. They will endeavor to demoralize the field of electric lighting so that legitimate business cannot stand the strain. Parent companies are selling to the gas interests—and they have the effrontery in their advertisements to boast of their success—apparatus that employs the very devices whose exclusive control had been guaranteed to the interests that the new purchasers are straining every nerve to kill. And this is being done at a most critical period, when depreciation is becoming known at its full value; when, owing to the general depression, market values of service are at their lowest, and when there is a strong tendency on the part of municipalities to demand of the electric industries expensive, doubtful changes, and to curtail their privileges and reduce their rights. The manufacturing companies are indirectly and directly promoting this tendency, and are inciting municipalities to purchase plants, thus depriving local companies of that profitable service which they themselves have created. To the one hundred thousand stockholders in the local companies of America is chiefly due the establishment of the new industry. They have produced the sinews of war, and by them the battle has been fought and won. From them parent companies have derived support which has made them what they are. For this veteran service and this timely support what return do parent companies make? Having possessed themselves of many millions of our hard earned money, they are now violating their most sacred obligation and betraying us to the enemy. You, Mr. President, like Agricola Senex in the fable, have nurtured a viper in your bosom. You have created a Frankenstein monster who now turns his hand against you, and I warn you central station men of America that if you would save your millions you must prepare to carry the war into Africa with respect both to the gas and to the parent companies. These two interests, with their pronounced porcine proclivities in common, must both be considered in this connection. The gas companies have, not without a certain assurance, fought well to concede to us the period of experimentation, believing that through the treachery of the parent companies they could easily step in and capture the business when its permanent value became known. After we have paid the score and quaffed the froth they, like the thirsty soul in Virgil, intend to seize the bowl and drain it to the dregs. But, Mr. President, if to them we seem vulnerable on account of the prices which we have paid for apparatus, let us not forget that they too have their undipped heel. Their plants also can be duplicated at much less than their original cost and by improved processes their rates can generally be greatly reduced and still leave a larger margin of profit than most of us enjoy. Indeed the gas field is a most attractive one. For while gas is fast losing its place as the leading illuminant, it is certain to be the fuel of the future, and fuel will always be more generally and largely used than light. Fuel is everywhere a necessity, while light is largely a luxury. I therefore advise every one interested in electrical central stations to investigate the gas business, subscribe for the gas journals and let slip no opportunity to gather information regarding this great industry. With regard to the parent companies I will say that you central station men who have created these companies have the power to check their rapacity and if need be to destroy it. Your interests are identical. You have a peculiar element of strength in that you do not seek to serve the same customers, and can therefore never be brought into conflict one with another. Your investments now aggregate upward of one hundred millions and with stockholders among the best business men, the leading men of affairs in America. You have the power to inaugurate a movement and carry it forward which will be irresistible. Why should this army of producers, with their one hundred millions of active and productive property and their inexhaustible resources submit to the extortions and treacherous attacks of a few syndicates, who are little more than brokers in material, whose bona fide investments aggregate about twenty-five millions, and whose factories can be duplicated, yes, and greatly improved upon, for one-half that sum? Let us enter into a compact whereby we will pledge ourselves to purchase apparatus only of those companies who will treat us fairly, and in case we cannot get such fair treatment, in case we are met by a combination, a trust or a pool on the other side, let us pledge our united support to a new manufacturing enterprise which will enter the field with this guaranteed business to rest upon, and Mr. President, if as a last resource, if the worst come to the worst, let us with our upward of one hundred millions of investment call into a common fund from one to five, ten or even twenty per cent. of our investments and standardize our apparatus and do our own manufacturing. You, Mr. President, well know that there are already upward of twelve millions pledged in writing to this movement. Your committee should push this work forward with all possible vigor, as it cannot fail to result in the greatest good to the greatest number.

Judge ARMSTRONG: Mr. President, as chairman of this committee, I have listened with a great deal of interest to what has publicly been expressed and so ably expressed by my fellow member, Mr. Weeks. Since I have been a member of this association, this one question has been discussed with more vigor outside the meetings of the association, and when we have met one with another, than any other question, and, indeed, it should be discussed not only outside, but inside, because these very evils that he speaks of are the most dangerous things that we have to encounter in this business in which we are engaged. Now there should be no conflict of interests; there should be no throat cutting in this, because it is absolutely essential that we establish firmly this industry. Have any of your companies attempted outside of your own circle to place your securities? Have you attempted to do business outside of your own immediate circles? those with whom you are particularly interested. If you have you have been met by just exactly these things that shrewd business men could see. If we are bound to be subject not to fair competition, not to the ruling markets, not to anything of that sort, but if we are bound to be subject to raids, where will it end? How will the business be advanced? How will enterprises be exploited? How can we carry on, as we hope to do, the business in which we, as pioneers,

have engaged? It is very natural, that if we, as lighting companies, come into a territory and propose to succeed some other method of illumination, it is very natural that that method of illumination should seek to oppose us. No matter if they realize, as almost invariably they do, that we can give a better thing, better suited for the purpose, do better work in this line, it is not natural that they, representing their stockholders, should sit by quietly and let us take the field. They might as individuals, as citizens, condemn the fact and lament the fact that their interest as stockholders, as directors, as managers of another thing, makes them oppose this advance; but, nevertheless, they will oppose it, and when they can be met with the encouragement, with the assistance, aye with the direction of those who ought to be the last to encourage them, those who ought to be the first to discourage them—I say when they can be met by that it is no wonder that our enterprises are hampered as they have been, and as many are to-day represented here upon this floor. Now, Mr. President, it is not a desirable thing that any of these methods that Mr. Weeks suggests should be engaged in by us as corporation or by us as individuals. Not one of them is to be commended. I will take that back—one of them is to be commended—that we engage to deal with those who will deal fairly by us. That I do heartily commend. But the others I cannot commend, and as I take it he does not commend them either. No more does he commend the necessity that there is to build fortifications, to raise armies, to engage in war. No more does he deem it an advisable thing to take physic, and yet all these things, under given circumstances, are necessary, and as I understand it, these circumstances are with us to-day, and if we suffer them to go we will be in the position of a state that permits a host to fully arm and equip itself and come against it and it remains defenseless and unprepared. We will be in the condition of a man who suffers the inroads of disease to come so that there is no possible hope of recovery, no matter how much he may subsequently physic. Let us at this time diet ourselves. Let us at this time prepare, so that encouragement will not be given to those who seek to come against us. As I understand it, Mr. President, when this committee was first appointed at Kansas City it was with the idea of formulating some plan, doing something; only, however, because it was supposed that central station men would come to them with suggestions and explanations and experiences, so that we might before this have gone on to prepare against this day that seems now upon us. As I take it, this resolution that Mr. Weeks has offered means that now we, as an association, through our committee, shall prepare some definite plan by which, because of its object, we agree firmly to stand, and by which we propose firmly to establish the business of our constituents. I am heartily in favor of taking the most vigorous method, using the strongest possible means that we can, firmly to establish our business, and I am more in favor of that for the reason that any such act cannot by any possibility hurt any legitimate enterprise. If that be so, no man can condemn what we suggest doing to-day.

Mr. WILMERDING: I do not think, Mr. President, that any central station man can differ with Mr. Weeks and Judge Armstrong on this point. We all know what experience some of us have had. Personally, I cannot say that we have suffered very much, and a combination such as has been suggested would take care of the future. That is what we want to look out for. I think that a gentleman present who has had more experience in this line than I, can say more to the point than I can—Mr. Francisco.

Mr. FRANCISCO: I am rather peculiarly situated on this question. I have been hauled over the coals for the last two years for this very thing. I have been furnishing light at about one-third the cost of producing it on account of this kind of guerrilla warfare, so that I know something about it from actual experience. I am now, as I was at Kansas City and as I was at Providence, strongly in favor of this movement. and I hope that the central station men of America will take hold of this as a body and carry it through as a body, united and strong, and there is no question in my mind, if they will do that, but that they will succeed and that they will support themselves without any difficulty. It is not, as I look at it, a warfare. That is not the idea. It is simply self-protection. That is what we are after and nothing more. We do not want to inaugurate a warfare against the manufacturing companies or the parent companies. That is not the idea. But we want to simply say to them when we have purchased a thing we have the right to use it. What we want is protection. We want them to comply with the agreement they made with us, and we want the power if they do not do it, to compel them to do it. That is the position I take in this matter and the position that all central station men should take. Now here is a station established. I go to my people asking them to invest money. What object is there, they ask, in investing money? How do we know but what there are going to be three or four parent companies coming in and establishing plants just as they have done already, and compelling us to keep buying them off all the time. Now a company that is organized and started in business, especially in places not large enough to sustain two companies, the only object in establishing the rival company is to compel the original company to buy them off or to sell apparatus to some opposing company. If the second company can raise enough money, they will wipe out the first company, and go on until the parent company comes in and wipes them out. Now with this arrangement that has been discussed here, and was discussed at Providence, there is a united effort. The parent companies and the manufacturers understand that it is not for warfare, but simply self-protection, and that if they deal squarely and honorably with the central station men they will secure three times the patronage from those central station men that they can get by selling one or two plants to different parties scattered over the country. I have, unfortunately, been drawn into this controversy about municipal lighting, and have been very flatteringly noticed by some of the municipal papers over the country in a way which is not very cheering, but I have got so accustomed to it now that I do not think anything about it. In fact, if I do not see some article in regard to my theories and my quaint idea on municipal lighting, in some paper somewhere about every day, I think it must be that the matter is falling off, and that the principle of municipal lighting is rather going backward. But the same principle is involved there that is involved here. A city gets the idea that it can produce lights for about half of what the corporations can produce them for. Some parent company goes to the officers of the city and proposes to put in a plant. Now, they are not only going to furnish the city lighting, but they are going to put in lights and do commercial business right in direct opposition to the local company whose capital is invested there and whose rights that very city has guaranteed by contracting with it to do that business. Now, after they have invested their millions of dollars in that property, this parent company tells the city that it can produce its lights for half of what the local company is charging for them. Now, that is entirely wrong, and this combination of central companies should be made to meet that point right here, whether it is selling to cities or selling to other opposing corporations—I do not care which it is—they should be met there, and they should be forced to abandon that scheme and treat the local and present companies fairly and honorably. Mr. Wilmerding spoke of Chicago. I saw there was a bill introduced in the Illinois Legislature allowing the city of Chicago not only to produce its own lights, but to furnish commercial lighting all over the city of Chicago in direct competition with the local company there. Now, everybody knows what the result of those things will be. Everybody knows that if they can tax you and me to make up the deficiency that they can wipe out any local company no matter how large its capital. If the city has the privilege of falling back and taxing the people, of course there is no possibility of competing with them. I trust that this matter will go forward and that the men of this convention will take this thing by the horns and put it in proper shape and carry it forward.

Mr. T. CARPENTER SMITH: I have listened with a great deal of interest to Mr. Weeks, Judge Armstrong and Mr. Francisco's remarks. I was very much interested in one proposition put forward by Mr. Weeks where he spoke of forming a company for the manufacture of apparatus. I think that in that suggestion there is a weapon that lies ready to the hand of every central station man. We know that there is enough machinery on which the patents have entirely run out which can be used for nine-tenths of the lighting in an electric light station, referring more particularly to arc apparatus. The one feature in an arc machine which has been used to sell apparatus more than another and which has been used by parent companies, one against the other, is that of a good regulator. I have had some little experience—not very much—in arc lighting, and I have found that the best regulator of an arc machine is a good big load. (Applause.) Now I think that there is not a central station in the country but that has bought and paid for enough patent regulators to take care of all their small circuits—all their cut circuits—and I think if this committee put in the hands of every central station information that would enable them to buy machines which would run their full circuits and let them keep those for which they have already paid heavy prices to run their cut circuits, that you have got a weapon to bring the parent companies to a sense of what it means to lose nine-tenths of their business at once. I feel that this committee, if it be continued, should look at the matter in that light. It is information of that kind which we want circulated among the central stations. I know station after station that has enough apparatus to do its whole business which it cannot use on account of defects in it—its old apparatus—which could be fixed up and do efficient work if its men knew how to fix it. But the parent companies tell them it would be necessary to get new stuff. Advice to buy new material is what they are always met with. What the central station wants is information which will enable it to use its old stuff that it has already bought and paid for. I believe there is enough apparatus to-day in central stations to do all the business for ten years to come without buying another particle from the parent companies.

Mr. NICHOLLS: I am very much interested in the question at the present time, and I have listened with a great deal of interest to the remarks made by Mr. Weeks and by Judge Armstrong. I must say, however, that I have a good deal of sympathy with the parent companies, because as business men we all admire a company that is aggressive in pursuit of business, and while I admire their aggressiveness I must say that I question the policy of their procedure in these matters. It is far better, it seems to me, to have a healthy vigorous company in any one locality than two or three competing companies that are slowly dying of inanition and who are cutting each other's throats. But it seems to me, sir, that this matter has been so well expressed, that the different arguments have been so well put, that it would be a pity, considering the smallness of the attendance at this meeting, if the rest of the members who have not an opportunity to be present here to-day have to wait until the minutes of this association are printed in due form, and on that account I beg to move that the paper by Mr. Weeks, with the remarks of Judge Armstrong added thereto, as taken down by the official stenographer, be printed in the form of a pamphlet at the earliest possible moment, out of the funds of the association, and sent to every active member.

Mr. SEELY: Is this the final report?

The PRESIDENT: I will entertain your motion, Mr. Nicholls, later on, after consideration of the report of the committee.

Judge ARMSTRONG: In reply to Mr. Seely's question, I would simply say that the committee's report was that nothing had been offered by the membership of the association to the committee, and under the line of its appointment it did not understand that these various things could be entered into by it. It was to stand more as an arbiter between parent and sub-companies where this question arose, and while outside there has been the greatest amount of muttering and discontent and feeling, as has been well expressed here to-day, yet so far as the committee is concerned nothing had come to it. There was no necessity for the parent company to come; it did not care to; it wanted to be let alone. None of the sub-companies seemed to understand that they were to bring in their grievances, if they had any, to this committee, and the suggestion of the committee was that if it should be continued there should be some definite direction given to it to take the initiative, or else that the committee be no longer continued as one of the committees of this body.

Mr. Weeks wrote out and handed to the secretary the following:

I move that the Committee on Relations between Parent and Sub Companies be instructed to formulate a definite plan of procedure for the protection of the central station companies and prepare the necessary articles of agreement, and report the same to the Association in executive session at its next convention.

The motion was seconded by Mr. Seely and carried.

Mr. Nicholls' motion that the report of the committee and the discussion thereon be printed and distributed at the earliest moment was carried.

The PRESIDENT: I will call now for the report of the Committee on Data.

Mr. H. M. SWETLAND: In the absence of Mr. DeCamp I have been requested to prepare and submit the report relative to the comparison of standards of economy in the generation of power.

The motion that that committee be continued was carried, and the report was read.

The PRESIDENT: Director General Davis has sent here as a representative of the World's Fair the secretary of the electrical part of it, Mr. Hornsby. I take pleasure in introducing Mr. Hornsby to you.

ADDRESS OF MR. HORNSBY.

Gentlemen of the Electric Light Association—The World's Columbian Exposition is very much pleased at the action taken some time ago by your association in the appointment of a committee on World's Fair. That courtesy is responsible for my presence here to-day as the commissioned officer of the World's Fair, representing especially the electrical department. I had intended reading a paper on the subject of the World's Fair as a whole. You gentlemen are, however, a technical people, and I will try to explain to you practically, instead of reading a paper, just what is contemplated. This [pointing to a map] is the site of the World's Fair. It is 646 acres, 100 of which is to be under roof. This is the north of the park—this the south. This is the lake. Beginning with the lake for purposes of description, there is a breakwater construction along here with a pier running 1,000 feet this way, with casinos, statues, fountains, etc., along here. This harbor is for pleasure craft—electric launches will ply there. This is for the entrance of boats. At the grand entrance there is a large archway over which will be columns of electric search lights for the lighting up of the harbor at night. Just here is the colossal statue of Columbia. About here are the statues emblematic of the thirteen original States of the American Union. This is the grand entrance to the World's Fair. Here is the Administration Building, which will be the crown jewel in the diadem of buildings. This building will be 260 feet high, with domes, colonnades, grand entrances—four of them—ninety-four feet in height. On the right of this building going in is the Manufacturers' Building. These buildings will be devoted to the liberal arts. That building will cover thirty-four acres. It will be dome shape, 1,800 feet long by 900 feet wide, that span arching to support the dome 388 feet across. The building will be 280 feet high and will cost $1,000,000. The contracts are let and this building is all under way.

The Machinery Building, which will be 500 feet by 900 feet, is to be in every way a modern structure. It is impossible just at this time to tell how far the machinery department will go and where the electrical department will end. In the discussions of the Classification Committee of the World's Fair a year ago the electrical department was given a group under the department of machinery and assigned to a corner of Machinery Hall. Its part was inconsiderable and very little was thought of it. The two learned gentlemen who assisted the commission to make the classification insisted that electricity was a branch of machinery, and as such was entitled only to the consideration of being grouped

with machinery. That has been changed; it is not so now. Electricity Building is 700 feet long by 350 feet wide, having 240,000 square feet of floor space. It has a 100-foot gallery around the entire extent at an elevation of 38 feet. The roof is 160 feet high, dome shape. It is in the Italian Renaissance architecture, under contract to cost $650,000. That is to be purely for the electrical exhibits. The exposition proper—the magnitude of the Exposition can be regarded from this standpoint and it is something that you gentlemen will be perhaps more interested in—that is the Electrical Annex. The building for the service of the exposition with electricity occupies a larger scope than it did. Electric launches will be here. An electric intramural railway will traverse the entire length of the ground. This is a mile and three-quarters. The road will be three miles or thereabouts long. Electrically propelled elevators will be in all of the buildings. Everything that is done in the shape of power will be by electrical transmission. This will be an expensive plant. The various companies engaged in the supply of power and light will be contracted with to build modern lighting and power stations of their own, after their own plans, to be approved only by the exposition management. This will be a 24,000 h. p. plant—a large one as you gentlemen will know. The distribution from here will be in three directions. These are the terminal tracks for the handling of passengers. Along here will be a tunnel passing down through the Mines Building, which is here, the Transportation Building and its annex, the Horticultural Building and the Women's Building,—these will be supplied from one source. Another tunnel will be built over here across this way striking the corner of the Mines Building, and passing through over to the Electricity Building, and passing through and from there across this bridge, crossing the canal down through the Manufacturers' Building, the Government Building, the Fisheries Building and this pier on which will be casinos, statues, fountains, etc. A short tunnel will be built from this power house, going first through Machinery Hall, crossing this bridge here, down through the Agricultural Building, the Agricultural Annex (the saw mills will be run entirely by electrically transmitted power), the Forestry Building and the Dairy. From this plant will be served 8,000 arc lamps, 85,000 incandescent lamps and 4,000 h. p. for the operation of the machinery belonging to exhibitors.

This is a wooded island 30 acres in extent. This island, the lagoons, canals, all of the grounds, will be lighted by electricity. All of the buildings will be lighted by electricity. In our own building I have recently finished the plan. We will require in that building and have arranged for 800 h. p. for the running of exhibits aside from the operation of exhibits from the exhibitors own plants which will be located here as well. In there we will have light proportioned one 2,000 c. p. lamp to 1,000 square feet of space. In addition to that, in the centre of the building we will have some spectacular effects, and in all of the corners; 700 arc lamps, I believe, are destined to that building.

So far as we are concerned ourselves, the electrical department has been divided, the service being absolutely separated from the exhibition department. All of the exhibition will be under the superintendence of the chief of the department of electricity. Everything electrical in the exposition will be on exhibition. But this plant here will be purely a service plant, the exhibition feature to be a secondary consideration. It was contemplated originally to install there a service plant proportioned to the good will of the electrical people—free lunch, as some one has been pleased to call it. The management of the exposition thought it would be impossible on account of the general interest taken in the exposition to have the electrical people donate for the use of the exposition enough apparatus and enough talent to serve the purposes contemplated. By the hardest work and closest application of the electrical department we have made it appear advantageously, and certainly for the benefit of the electrical people, that that course would not be in accord with their wishes. Their interest would be dampened if such a procedure were to be inaugurated. Therefore, we have been successful in having this plant installed purely as a business proposition, the idea being to demonstrate unequivocally and in practice the economy of an electrical service over that which was contemplated before—steam and gas. In that far we have been successful, and after the Columbian Exposition I think that we will be able to demonstrate fully all that has been claimed for electricity on the score of economy, comfort and luxury, if you please.

I have been in correspondence for six months or thereabouts with electrical people in all parts of the world relative to the holding in Chicago in 1893 of an International Electrical Congress. I have arrived at a point in our correspondence and negotiation at which I can say the project is in the way of being successful beyond our highest hopes. We look for the presence in Chicago at that time of the ablest men in the greatest profession now in existence. The Europeans have promised to have their very highest authorities with us. The best of the electrical people of this country are heart and soul with us. The representatives of the societies in this country and in Europe have signified their intention of taking active hold of the matter of holding this International Electrical Congress. A good many of these congresses have been held heretofore, largely in Europe. A good deal of satisfactory work has been done in the settlement of standards, the unification of methods, the revision of nomenclature—all of those things. Very little, however, of that work has been done in this country. It seems to be the feeling among scientific men that we are on the eve of a greater revolution than has taken place in the last few years. The chasm which stands between what we know and what we do not know is deep. It may be unfathomable and the hidden recesses of nature may not be for our exploring. On the other hand some men in the vanguard of this work may brush aside the veil that hangs before us and reveal the thing that has been sought so long. The great revolution may be at hand. Why then may not this be the time? The bringing together the Nestors of our science, the concentration of thought, the settlement of methods—all of these things will tend to great good. The standards in the profession can be more fully settled. Unquestionably the nomenclature of the science can be revised at least in some particulars, and to the world in general such a congress as this would do great good. The question has come up whether this should be done through and by the World's Columbian Exposition, or whether it should be done by the various societies. The question should be answered in the affirmative in both instances. It should be done by the societies. They have largely contributed already. It should be done under the auspices of the United States government, which is the authority for holding the World's Columbian Exposition. As the representative of the electrical department, as its accredited commissioner to this convention, I will say that the exposition management stands ready now and at all times to aid such a movement in any way. A provision has been made in the report of the presiding officer of the exposition management which will be read before Congress next winter with a view to having the government of the United States take official notice of the contemplated electrical congress. The management of the exposition have already acquiesced in the proposition to build a hall for the holding of this congress on the exposition grounds. All of the adjuncts of debate will be present. No money will be spared by the management to make the congress in every way a successful one, and I do hope that at this meeting of this association—strong, powerful, prominent, representative as it is—some action should be inaugurated, looking to the starting of the ball which shall roll to be a gigantic one. Something should be developed at this time that would give us a nucleus around which to work. In the course of time the other societies will take their part. The Electrical Engineers, I understand, have gone far already, and with the help of such societies as these we have no question about furthering a proposition to hold an International Electrical Congress.

Mr. T. C. Martin: Mr. President and fellow members—Mr. Hornsby in his remark has made reference to the work of the American Institute of Electrical Engineers in connection with this congress, and I think I may briefly state what has been done, and then, if you will allow me, suggest that this association act upon somewhat similar lines.

Two and a half years ago, at least, at any rate before it was known that the World's Fair would go to Chicago and when some of us still fondly hoped that it would not, the American Institute of Electrical Engineers, taking time by the forelock, appointed a committee to secure the holding of an electrical congress or conference in this country. A congress was then about to be held in France, at Paris at the Exposition, and we sent delegates to that congress. Those delegates—some of our most prominent electrical engineers and inventors, among them being Mr. Edison, Prof. Elihu Thomson and others of that rank—extended in the name of the institute to the delegates to that electrical congress an invitation to attend such a congress in this country during the Columbian Fair year. The invitation was received and accepted. During the present year another congress of like nature is being held at Frankfort, in Germany. That congress in France was held under the auspices, first, of the French government and of the exposition authorities, and secondly under the auspices of the French society. A similar procedure prevails at the present time in Germany with regard to the conference there, and it is being held under the auspices of the government and with the direct support and aid of the German society. Now I think that Mr. Hornsby has outlined to us just such a line of action for work in this country. It is proposed on the part of the institute, and when I say that I speak as secretary of the committee which has the work in hand, to work, as far as lies in our power with the World's Fair authorities, and we think that with the assistance and co-operation of such powerful bodies as this the congress that is held in Chicago in 1893 will not only be the most memorable but the most useful of all the congresses that have been held up to date, and as a member of this association I think it would be well in supporting Mr. Seely's motion to have a committee appointed that will work, that will commit this association unreservedly to the support of the World's Fair, and to make the movement in Chicago and the congress a success.

A vote of thanks was tendered to Mr. Hornsby for his full, interesting and explicit explanation and description of the plans for the Columbian Fair.

A motion that the committee be discharged and that the Chair appoint a new one was carried.

The Chair appointed as such committee Mr. B. E. Sunny, of Chicago; Mr. Coleman, of Milwaukee; Mr. Hart, of New Orleans; Mr. Rice, of Washington, and Mr. Price, of New York.

Mr. Peck then presented, as the report of the electrical section of the Committee on Data, a form by which to record data concerning street lights.

Judge Armstrong: I move that it be received and adopted.

Mr. Burleigh: And that the secretary of our association refer it to the Census Department at Washington with the request that they so arrange their statistics as to conform to that form.

Mr. Weeks: My attention has been called to a clipping from one of the Kansas City papers which I find noticed editorially in *The Electrical Engineer* of Sept. 9 regarding the price of street lighting in various cities of the country. I take it that if data are to have any value whatever they should be accurate, and I am very sorry to see that the data that are given by the Census Department in Census Bulletin No. 100, referred to in this article, are not accurate. For instance, the statement is made that in San Francisco the price is $440.67 for one arc lamp for one year, and in Denver $58.46. Those statements are made simply without any qualification whatever. I happened to be familiar with the facts in both cases, and I know that there is no foundation—absolutely no foundation for those statements, and I think that it is but just to our good friends, Rollins, of Denver, and Roe, of San Francisco—than whom there are no fairer minded and more just men in the fraternity—that that statement be corrected. The facts are that in San Francisco, where it should be remembered coal is $7 per ton, the highest price paid for any one lamp per year is $361.90, and that is a 4,000 c. p. lamp maintained at a point remote from the central station with a considerable mileage of circuit in order to reach that point, of course; and instead of being so generous, as one would infer Brother Rollins has been in Denver to give them an arc lamp for $58.46, his good business sense has led him to do quite otherwise. The rate that he gets there is $150 within a certain radius and $216 outside and for tower lighting, two very different propositions.

In this connection I want to call attention to the amendment that was suggested by the committee to the scheme proposed by Mr. Foote, that a very important factor in this whole matter—one of the most important factors—is the question of distribution. I have had occasion to look into this matter quite extensively of late, and I find that the distribution of municipal lights ranges all the way from eight and six-tenths lamps per mile of line down to one lamp per mile of line. Any electrical engineer will at once appreciate the importance of this, and that element should always be included if a comparison of prices is made. Of course there are other elements that occur to almost every one—the system used, the watts consumed, the period of contract, the price of coal, whether it be water power or natural gas—but the mileage of circuit per lamp seems to have been generally overlooked. It is important in two ways—first, it determines the amount of investment. I find in the cities that I have looked up that the investment per lamp in street systems ranges from $35.87 to $190.40. You can readily see that when it comes to operation it will be still more important, as not only has the resistance of the line to be overcome, but it has to be controlled and maintained, and your trimmers have to traverse all of this distance.

I want to say that I think that Mr. Foote in the schedule proposed has covered the ground very thoroughly with the amendment suggested by the committee. I hope that he will find that it will be readily filled out by the central station men.

Mr. Francisco: Mr. Weeks' remark, calling attention to this matter of price, and to the statements which have been published through the country with regard to street lighting, led me to suggest that there are so many factors that enter into the question of cost that it is utterly impossible without some such information as we can get from this census matter to tell anything about the matter in any way, shape or manner. You will often see published in the newspapers and magazines statements of the cost of street lighting in different places. They will give the cost in Boston, where steam power is used, and coal is $5.50 per ton, and compare that with the cost in some place in the West, where water power is used, and no coal is required, and where they are burning in one place 1,000 lights, and in another 50 lights. As Mr. Weeks says, there is just as much difference in the cost of producing light, whether you are running a large number or a small number of lights, as there is between burning coal at five or six dollars per ton and using water power costing nothing. In the information which has been disseminated through the country for the use of municipalities those things have not been brought out at all. They have simply said that light in one place costs so much. In one article which I read I saw the statement published that Boston had to pay $180 per year, while Ypsilanti only paid $13. That would carry the idea that the citizens of Boston were being outrageously swindled, whereas the fact is that Ypsilanti uses water power, while Boston uses steam power. You cannot make a good comparison of those things without you have such facts before you. These statistics that Mr. Foote will furnish may cover that very ground, and will show up all these different points, so that you may make a comparison and make it intelligently. I trust therefore that this matter will be thoroughly carried forward.

Mr. Foote: You all know that this subject is one which interested me before I had anything to do with the census. Mr. Weeks has called your attention to some things that the census office has done that on the surface presentation seemed to be hurtful. I took a little consolation out of those figures, thinking that if they hurt you pretty badly it would show the necessity of giving correct data on my schedule, so that I could make a report which would help you out of the dilemma. I have prepared a schedule that contains a number of points of inquiry. I submitted that schedule to thirty-seven managers of companies, every one of whom when they first took up the outline commenced by the wise remark, "cut it down." The net cutting down made by the thirty-seven managers was an increase of five points. The outline for street lighting reports that has been submitted to you can be filled out from the information to be obtained by those schedules, provided

we get the information on the schedules. Mr. Weeks calls my attention to the fact that he wanted a mile of circuit included, but I cannot make a report on a mile of circuit unless you give the mile of circuits on your reports to me. Some of you may think it strange, but the fact is that a great many central station companies do not know anything about the mileage of the circuit. Knowing how difficult these things were to reach, and knowing the necessity, the supreme importance, of having these figures correct when published, I have induced the superintendent of the census to appoint Mr. Foster as a special agent to visit central stations in the State of New York, go over the schedules with them, correct and verify their statements, and give his assistance to them in filling out those schedules, so that I may feel when I have the figures for tabulation that I have something which is *bona fide*, something which is reliable and which can be accepted as an authority by the people of this country on that question. That work will be pushed to completion as rapidly as it can be done, and I hope that every man that Mr. Foster may call upon will see the importance of laying aside his business for the hour and giving Mr. Foster the time, so as not to hinder him in his movements, but let him complete the work as soon as possible. I believe that it is possible now with the opportunity that we have to so formulate a report for the street lighting, contracts and prices that it will forever wipe out these strong figures, commencing with the highest priced lamp found in the country and ending with the lowest priced lamp, with no details given to show why one is high and the other low. You need the most intelligent men detailed to show and explain the figures, so that they may be made understandable and may serve as a guide for the action of those who undertake to discuss these questions. The more I have had to do with this problem of data and statistics the more conservative I get, and the more afraid I am of making any statement whatever with figures. My friend Mr. Tiffany who published that bulletin started out on the theory that he must ascertain the number of miles of street in town, and the number of lamp-posts in a town, and he simply passed every post that had a lamp on it as one lamp, as he unfortunately called it. He ought to have called it one post, and then it would have been all right, but he made no discrimination between an eight foot gas burner on a post, a kerosene lamp on a post, and a tower with 2,000 c. p. arc lamps on it. He counted them all as one post, and his schedule is worked out upon that theory. I think you will find, if you have the necessary patience for this work to be done (and it takes time to do it) you will get a report that will absolutely relieve you from all the difficulties you have been under in meeting these figures as to the cost of public lighting. That we will give you as soon as possible, having the two features always in reserve: First, that you give me the figures that are correct, and second, that the census office give me a sufficient amount of clerical help to do the work, both of which are very necessary things. What we want to have is figures that will not lie, and in order to have those we must have figurers who will do correct work.

The motion as made by Judge Armstrong and Mr. Burleigh was carried.

Judge ARMSTRONG: The Committee on Legislation has no report to make. The design of that committee was that the members from each State would give the matters of legislation occurring within his jurisdiction to the chairman of the committee so that it could be formulated and submitted here—a splendid scheme, but unfortunately it has not worked at all. In my own state (New Jersey) the legislature was so busy with political matters, fortunately, as to leave us almost entirely alone, and I think that is about all we need to ask in the way of legislation, to be left alone. I believe that the usual number of underground bills were introduced, and I think that one bill, which I referred to at the last convention, about getting away up in the air some two or three hundred feet, was also introduced, but nothing came of any of those measures. And so, reporting for that committee, I can only report for New Jersey. I do not know whether any of the other members of the committee here present are able to report for their own States as to matters of legislation or not.

Mr. WILMERDING: In Illinois, at the last session of the legislature, there were a great many bills introduced with a view to knocking out our interests. One bill was the one referred to by Mr. Francisco, by which the cities and towns were authorized to carry on a commercial lighting business, not only with electricity, but with gas. That bill died in the committee. There was another bill introduced to the effect that no wire should be operated in the State carrying a voltage of more than one thousand volts. That also died in the committee. We were fortunate in having one or two friends in the legislature who had influence enough to knock out those things. Of course we have all got to look for just such action. I suppose it is sandbagging, but they did not make much out of it, and perhaps next time they will not attempt it.

Mr. FRANCISCO: As a member of the committee from Vermont, I will say that our legislature only meets once in two years, and therein we are fortunate. We have had no session since the last meeting.

The PRESIDENT: In the absence of Mr. Maher, who is the member of the committee from New York State, I will say that each year in New York we have had a bill up (we had one winter before last, and there is one down there now) but, as is usually the case in New York City, the tail was trying to wag the dog. In other words, the members of the Electrical Commission in New York City are getting a good fat salary and they want to nurse that thing as long as they can. The bill contemplated would wipe them out. So we have got them fighting among themselves, and the result is that nothing has been done in New York State, and we are liable not to have anything done. The coming winter I presume that the same thing will be up, as I know of a gentleman who is a very hot candidate for one of the commissions, but I have no doubt that some of Mr. Seely's friends, Jake Hess or Theodore Moss, or some other one over there, will be as anxious to retain their positions as they were last winter, and so the tail will still wag the dog as it did last winter, and we will not get any legislation prejudicial to their interests.

Dr. BELL: I would like to ask, partly as a matter of information and partly as being upon a subject that might develop into something interesting, and as relating to a subject in which I feel a considerable interest, as I have had my attention called to it in one way or another in the light of these obnoxious bills—I would like to inquire whether there has ever been any systematic attempt to find out the nigger in the fence in this business? In other words, whether a majority of these bills emanate from cranks, from quasi socialists, from previous competitors, or from what source. Sometimes a little information as to just what is being worked to further a particular bill might be very useful in assisting various members of the association in meeting such measures.

Mr. ARMSTRONG: If the stenographer will not report what I say, I think I may answer Dr. Bell's inquiry.

Mr. SCOTT: I just want to speak in relation to this matter that the gentlemen have spoken about, so far as to suggest that sometimes legislation is produced by the indiscretion of electric light companies themselves. In Pennsylvania we have carefully watched the legislation, and have tried to have everything avoided that was inimical to our interests, but there has been a bill passed at the last session which directly strikes at and affects their interests, and which should not have been passed at all, and could not have been passed (for there was no money in it) but for the determined efforts upon the part of its promoters to have the bill passed. That was a bill in relation to the cutting of trees. It is a most iniquitous piece of legislation so far as we are concerned. It provides about in this way: That any citizen, any person, in any borough, township, or in any city of the first or second class, who has knowledge of the cutting or trimming of any tree along or upon any public highway, or the branches of trees upon private property, which protrude over the highway, by any telegraph, telephone or electric light company, and who shall lodge proper information, that thereupon the Court of Common Pleas shall appoint a jury of view, and that jury of view shall proceed to assess damages and costs upon such telegraph, telephone, or electric light company. There was an influence brought to bear in favor of that bill which could not be overcome. Some of us took the trouble to contest it, and found that the Suburban Electric Light Company, of Philadelphia—a county company—had asked the land association along their route for the privilege of cutting trees. They went to the secretary's office and asked for this privilege, and he said, "Yes, you can cut all that you want to"—meaning just to cover the right of way outside of their fence. But that company went to work and cut trees down that were inside of the fences. Any one traveling from Philadelphia to New York can see for over half a mile the fine trees lying right there on the road alongside the railroad track, along the State road from Philadelphia to Trenton. Well, it was a bad thing to do, and the land association, which is composed of politicians of Philadelphia who can carry any measure through the legislature, decided at once that they would stop that business, and so they put this bill through. So that it is not merely the aggrieved property owner, or anybody who may have any particular interest in the matter, but any tramp who comes along the road may lodge an information before the Court of Common Pleas, and then the damages have got to be assessed, even if it is only ten cents upon that tramp. Those things ought to be looked into. We ought to be careful on our own part in seeking legislation—just as careful as if it were legislation by our competitors or by our enemies. There is another matter of legislation that we have tried to accomplish in Pennsylvania. It is understood by every one who has had interest enough to look the matter up, that gas and water companies have an exclusive right—such an exclusive right that electric light companies cannot get in. Now, there is no more reason why an electric light company starting in a small town, like our own town of Bristol, of eight thousand inhabitants, against a gas company which has been running since 1856, and has been paying eight or ten per cent. dividends right along, there is no reason why that gas company should have exclusive charge, whereas an electric light company, after having invested twenty or thirty thousand dollars in its plant, and having finally got the thing running, should be compelled to buck against any one who may choose to come in and make a competition. Those matters can be arranged in time, but of course it may take a long time, and it will require a great deal of trouble and effort on the part of somebody. We can do a thing of that kind in a better way than by the use of money. We can accomplish what we wish by argument. If you will just show the people who are interested in the corporation—your own stockholders, the men who have put their stamps down for the purpose of carrying on that business—that there is something that they have got to look out for, that just as soon as you begin to make eight or ten per cent. and to accumulate a surplus, the gas company or the water company in their own town, using the power which they can apply to that purpose, can run a pole line right along the side of us, and can take our customers right away by cutting our rates, that they can do this because they have an exclusive charter, whereas we cannot go in and manufacture gas, or put water through the streets as they can do; I say that if you make your stockholders understand this, you may accomplish much. There are a great many of those questions that come up in this country, and that ought to be looked after, not only by the Committee on Legislation, but it ought to be the business of every man connected with a central station company, from officers to stockholders, to look out in this way for his pocketbook.

Dr. BELL: There is one further suggestion with regard to the matter of legislation that I would like to bring before the association, more perhaps for the purpose of getting the facts about it than for the sake of suggesting any possible remedy—because it would require a careful study to do that—and that is the existence of the fake electric light companies—companies existing on paper, with a board of stockholders, usually composed of the stockholders of the gas company, holding meetings once a year if it is absolutely required by law, and existing simply for the purpose of stopping legitimate electrical enterprises. I speak with some feeling on the subject, because I have happened to live at one time and another in two or three towns of comparatively small size, where this particular kind of work was being carried on deliberately by the gas company. They had obtained charters, and they simply hung on to them, stayed there like dogs in the manger, refusing to let any electric light company get a foothold, and stopping the organization of new companies. Even if they were not possessed of exclusive charters, their mere existence in a state which might become on very short notice active, simply checks opposition, and enables extortionate rates to be secured for gas, and preventing at the same time anything like the organization of an electric light company. In the first place it is an outrage upon electrical people in general, who want to see the electric light extended, and in the next place it is particularly tough on companies which might if permitted in towns do a good deal of electric lighting. It is hard on all parties concerned. I do not know whether there can be a reasonable possibility of legislative prevention of this, but it would be a mighty good work for this association to take up.

A motion that the report of the committee be received and the committee continued was carried.

The PRESIDENT: Next in order is the report of the Committee on Underground Conduits and Conductors, of which Mr. Francisco is Chairman.

Mr. FRANCISCO: In behalf of the Committee on Underground Conduits I have to say that we have undertaken quite a task. We found that the subject of underground conduits was one that was liable to involve quite a study in relation to a great many statistics and a great many points. We went to work to get at the bottom—to get at the facts. We have collected a good deal of information in regard to that matter, but the time has been so short that we confess it has been impossible to get all the matter that we had prepared the report on ready at this meeting. I have been in correspondence with parties in London with regard to the entire underground conduit business of London, but the report that I expected to have here to-day has not yet arrived on account of the time being so short in which to get the correspondence back and forth. The same statement is true with regard to several places in the United States. Therefore we did not feel like making a report which contained merely a partial statement of facts, because, as several central station companies had stated to me that they do not want anything but facts, and that they want to base their calculations upon what we find to be facts with regard to what they are going to do. The position that I have taken, and that the committee took is, that if there is a system of underground wiring that is practicable and proper we want to find out what is the best system, and then leave those that want to adopt it, upon the information which we may obtain, to decide as to that which is the best, the most practicable and the most serviceable. We cannot get the information and come to that decision in the time alloted for making our report at this meeting. Therefore we shall have to ask the convention to extend the time if they want the information.

On motion of Mr. Armstrong, seconded by Mr. Weeks, the committee was continued and requested to report at the next meeting.

The report of the committee on safe wiring was then read.

Mr. PECK: I move that the report of the committee be received and that the secretary be authorized to print the same at once and present copies of it to the members of the association, and that the discussion of it be made the first order of business on Thursday morning. It seems to me to be a very important report.

Mr. LAW: As I was perhaps as instrumental as any mem-

ber of the committee in preparing those rules for safe wiring I wish to call the attention of the convention to the fact that it is divided into three sections. I have found some misunderstanding with regard to that. One section says what you shall do, another section says what you shall not do, and another section says what you should do. Perhaps some of these sections that may look a little bit obnoxious to you may be those that would recommend you to do so and so, instead of saying that you shall or shall not do it. I call your attention to that so that you may notice these points when you come to read the rules.

Mr. Ayer: This is a matter of such importance that we ought not to pass upon it without having the paper before us so that we may have exact knowledge of what there is in it. As it is read before us none of us can fully understand it or take it all in. We may possibly misjudge it if we have not afforded us an opportunity to read it carefully. It is very important that all such papers should be printed and put in proper shape for circulation. It is possible that we cannot do this at this meeting; but with a view of not obstructing action on this thing, but of expediting matters, and of getting a set of rules adopted by the convention for safe wiring, I would suggest as an amendment to the resolution offered to have this printed at once, and the report circulated, so that it may be fully discussed. I think that it is wise that should be done. It will require a good deal of attention to properly act upon it on the part of the members. The members present are the only ones who are here to act upon it, and I doubt if we could possibly get action upon it at this convention in any other manner.

Mr. Hammer: I want to make a remark in seconding the motion. I have seen many of those reports, both across the water and on this side, and I can indorse that report as being the most complete thing of the kind that I have ever seen. It is concise. It goes right to the point. Undoubtedly there are in it some things that can be criticised by supply manufacturers, by wire men and by contractors, but as an electrical engineer who has had considerable experience in applying just such things from the incipient stages of electric lighting, I emphatically endorse that as being the best report of the kind that I have ever seen. I hope that it will come up for very expansive discussion. There are some criticisms that I would like to make, and there are probably some suggestions which could be advantageously made.

Mr. Brophy: I have labored for two years as a member of the committee on this subject. As a member of that committee I did not assume that we could not make mistakes. The subject is here for discussion, and for criticism by this association. If it is to be adopted by this association it should be done as soon as possible. I therefore hope that every effort will be made to print it, and to put it in such shape that it will be in circulation after the adjournment of this convention. I think that we can get it done, and finish this work up. The committee take a good deal of pride in being able to make a report at the next session after they were appointed, and we hope now to see our work finished here.

Mr. Mason: May I make a suggestion that will facilitate the matter? I move as an amendment that the report be printed with utmost dispatch and brought before the association thereafter at the earliest possible moment. Then we do not put off the consideration of it for two or three days, but simply until the earliest possible moment when it can be brought properly before the convention.

After some discussion the motion as amended was carried and an adjournment was taken.

THIRD SESSION.

The convention was called to order at 10:20 A. M., and the president read the following letter from the Canadian Pacific Railway Telegraph Company, dated Montreal, Sept. 8:

Dear Sir:

I beg to offer through you to the members of the Electrical Convention free telegraph privileges for social messages during your stay in Canada, over the Canadian Pacific Railway Company's telegraph, and I am also authorized by Mr. A. B. Chandler, the president of the Postal Telegraph Company of New York, to extend similar privileges over his telegraph system.

Yours truly,

Charles R. Hosmer,
Manager C. P. R. Tel. Co.

The president also announced that he had been requested by Sir Donald A. Smith to extend an invitation to the members of the association and their friends to visit him Thursday afternoon at his home from 4 until 6:30 P. M.

The first regular business of the day was the discussion on the "Distribution and Care of Alternating Currents," the subject of the paper read by Mr. T. Carpenter Smith, at Providence.* Mr. Law opened the discussion with the following remarks:

Mr. Law: I find that Mr. Smith has so thoroughly treated this subject of the distribution and care of alternating currents that he leaves but little to say. I most heartily endorse what he says of the short sighted policy of the majority of electric light managers in putting up cheap insulation; in other words the principal point of success in alternating works may be stated in one word—"insulation," for on alternating wires a short circuit or ground means, as a rule, a burnt out armature. For I find that in the most of cases the dynamo man gets tired of renewing the fuses at the generator and will put in a 160 or 200 ampère fuse on a machine that is only adapted to carry 130 ampères. I find that the better plan is on a 130-ampère machine to put in a 135 to 140 ampère fuse and then change it often, not waiting for it to burn out, but change it and put in a new one. By doing this you keep the machine fused very close to its carrying capacity and the fuse will then "go" before the armature will become overheated.

Not only should alternating lines be of good insulation but the primaries should in all cases be fused where they branch from the main lines to the converters. In other words, if you follow the insurance rules that have been presented to you for discussion, in primary construction the same as in secondary work, you will find, perhaps, an advantage in it. It is a very common practice to bring these branches directly from the mains to the converters without any protection whatever (other than the insulation on the wire) to prevent contact where one of these wires must cross the primary wires. I have seen a No. 8 wire burn off a No. 0 wire at the point where the primary loops cross the main lines, and a No. 0 wire charged with a 1,000-volt alternating current is not a nice thing to have down in the street, especially should the primary loops leading from the main lines to the converters be well insulated, for, as a rule, they are of small wire, because a large wire is not necessary. These wires are many times quite long, and being small they soon get slack, so that a good stiff breeze will twist them together, and unless they are all well insulated they will burn in two the first time that they are wet, and they are not pleasant things to meet on a dark night. If proper fuses are placed where the branch joins the main line, it is not only a protection to your machines and converters, but to life, also. When taking charge of a very large station, a year and a half ago, I found a great want. I am almost safe in saying all the primary fuses were removed from the converters and No. 14 copper substituted, simply because they sometimes blew out. Now, a properly placed fuse does not blow out unless there is a cause for it. There is the greatest of danger in not having the primary wire fused before reaching the converter, although there is a remarkable small number of burn outs in converters, yet when it does occur there is a danger of the primary wires becoming connected with the secondary, and you have a 1,000-volt current at your lamps. All converters are so built that a contact between primary and secondary coils is almost impossible, but if by a short circuit in your primary it receives a current of from 50 to 100 ampères, when it is only adapted to carry from one to five ampères, it will overheat to such an extent that it will burn any insulation which may be used. This is very liable to cross the primary and secondary wires and you have all the dangers of a high E. M. F. clear to your lamp socket. Properly fusing the primary wires will effectually prevent all this danger. One weak spot I find in alternating central station construction is the double throw switches. They are never large enough to break the arc which they are sometimes required to do, for it is not only to break the usual load of from 50 to 75 ampères on each circuit, but in case of a short circuit or ground it may reach three or four times that amount and the fire and noise produced in a break of that kind is only realized by those who actually perform the operation. Likewise the fuses are not one-half large enough to break radially. These fuses are generally placed on the back of a wooden switchboard and are a great source of danger from fire.

After Mr. Law had opened the discussion on this important paper, Mr. M. J. Francisco made the following remarks on the same subject:

Mr. M. J. Francisco: I find that Mr. Smith refers to underground and overhead wires. Now in the work in which I have been engaged for the last six months with regard to this underground business I have had a chance to meet this point of overhead and underground construction very generally, and my experience is that one-half of the trouble we have had in regard to underground and overhead work has been from the loose, miserable manner in which the overhead wires were put up. If the electric light companies themselves had thoroughly installed their systems and run their wires in a proper manner, spending perhaps what they have for underground work, we would not have had one-half of the trouble we have at the present time. In several cities I have visited in regard to this underground business the officials themselves have said: "Why, if you people would put your wires overhead in proper shape we would not have commenced this raid. But here are these wires strung in a slipshod, haphazard manner without any system or care, and in many cases without any real insulation, and, of course, we have to protect the public. We are here as officials to protect the public, and naturally if you people will not take the initiatory steps to protect the public we have got to compel you to." Many officials have told me that that was the reason of this raid, and I am satisfied that if the electric light companies would even now—of course in certain large cities there is not any question in regard to what should be done, for the wires must go underground anyway, whether it be practical or not, but in a large proportion of the cities you will find that if you will properly construct your lines, put them in proper order and keep them so, you will have no difficulty with the city authorities. I say this after having interviewed a large number of the city officials of different places. You will notice that Mr. Smith takes that same ground in his paper, and it is one of the best and soundest doctrines that has ever been promulgated in this association.

Mr. T. Carpenter Smith: I would say with regard to the placing of fuses in converters that our experience has been that, as a rule, there is little trouble with the primary fuse in the converter, except when you want to replace it. It is usually a very ugly job to replace a primary fuse in a converter. We have for a good while now left the secondary fuses out, and we have always followed the practice of putting a cut-out immediately at the converter, but on the outside of the converter, and we found that we had a great deal of trouble with the secondary fuses from the fact that they are heavy fuses and the contacts are not large enough. It is difficult to get contacts that will last three or four months without being corroded. We therefore put copper in these fuses and depended entirely on the cut-out which is immediately outside the converter. On the primary, in some cases, for large buildings, we put cut-outs on the pole and still kept the fuses in the primary end. But we had very little trouble with the primary fuse except in the case of short circuits, in which case the primary fuse always went. We never had any trouble with a short circuit from the blowing of the primary fuse, but I believe others have had that trouble—with the primary terminals being so close together when the fuse blew, the lead vapor will not cross. There are converters now made in which the primary fuses are put on a separate plug, and that plug is pushed in and can be taken out and the fuses replaced without touching any high tension wires or connections with the current on. That has another value, and that is that the fuses if required can be soldered into the plug, and spare plugs can be kept on hand, while a lineman can go around once a week or a month, or as often as is thought necessary, and by working the plugs he keeps the contact clean and works off any corrosion that may be in there and keeps a great deal of heat out of the fuses. That form of connection I spoke of—about having some arrangement made by which a fuse on the feeder should be on a switch so that the switch could be worked for keeping the contacts clean without cutting the current off—that is a point we have to keep clearly before us—that incandescent light to succeed must be as continuous as gas, and while a customer will not object to a wink in his light he will very strongly object to the light being out for four or five seconds. If the light merely winks on the changing of a switch, he looks up and the light is steady again, and he thinks perhaps he was mistaken and he does not take any further notice of it. But in a large house where large quantities of goods are handled it is very awkward to have the light stop four or five seconds.

Mr. Ayer: The point that I would like to get at is the leaving of the cut-out and fuse outside the converter box. It perhaps has some value in a short circuit coming on the loop. Bringing about a short circuit will only blow the fuse, which is placed in the cut-out of the pole, where, in the event of the cut-out being incorporated in the converter box, the primary fuse in that case would undoubtedly blow a fuse in the main feeder, also leaving a dangerous condition of affairs on the wires. Manufacturers regard this as of some practical value. They make a point of it in their literature, and indicate that it is preferable to keep the cut-out or switch in the fuse out of the converter box. The cost of construction is very much greater where the separate box is used, and it is a question whether it is desirable, of course, to obviate this danger of short circuiting on the loop. The converters may be placed on the pole and there is room for cut-outs. That would place the fuse at the point where it would be protection to the public as well as to the feeders. But I do not see the utility of separating them. There are two devices there, a cut-out and a converter. There are boxes which contain them. It seems to me that the one box should contain the two devices and they could be so arranged to do it properly. It is much more expensive to install as well as to buy. Different manufacturers take this different view—some favor incorporating that in the converter box with the converter and others leaving it out. There is no special reason why one company should not put them on unless they saw an advantage in it. There is no patent which would prevent their incorporating it in the box. That being true it seems to me it is a good thing to know. It makes quite a difference in the cost of installing the lights.

As there was no further discussion on this subject copies of the following paper of Mr. George A. Redman, of Rochester, N. Y., on "Central Stations Operated by Water Power," were distributed, and the subject was taken up for discussion.

CENTRAL STATIONS OPERATED BY WATER POWER.

By Geo. A. Redman.

The purpose of my paper is more to give a description of what is being done with water power for electrical purposes in the city of Rochester by the three different electric light companies doing business in that city, and some of my own experience with water power, than to take up your valuable time with the technical description of turbines, which can be gleaned from any of the numerous catalogues of turbine manufacturers, which contain full descriptions of turbines and their construction.

The adaptation of water power for electrical purposes has grown very rapidly within the past few years; there are sev-

*For the full text of this paper see The Electrical World of Feb. 28, 1891, page 172.

eral causes operating to enhance the value of water power, none more so than electricity.

Streams that have had no pecuniary value heretofore are now being utilized for the purpose of running electrical machinery, yet at the same time the supply of water is diminishing, caused by the destruction of forests, and water rights owners in various parts of the country are devising means of storing water during the rainy seasons to furnish a supply during the dry season; also storing it in the daytime for night use. One large water right owner in Western New York, during the months of July and August, places flush boards two and one-half feet high on top of his dam, at an expense of $100, and stores up for night use the water which it is not necessary for him to use in the daytime, thereby saving in the two months equivalent to a coal bill of $1,100.

The Johnstown, N. Y., Electric Light Company has improved its water power at the Cuyadota Falls by erecting a dam 34 feet high on top of the falls, giving a total head of 75 feet and nearly doubling the amount of power.

A survey of the upper Genesee River, between Mount Morris, N. Y., and the celebrated Portage Falls, has been made during the past year for the purpose of establishing a reservoir that will furnish the city of Rochester 30,000 h. p. more daily during the entire year than they have at present.

The earliest forms of water wheels were the paddle and flutter wheels that only utilized the impulsive action of the water; these were followed by simpler wheels of the reaction type and others.

We now have the improved forms of the Leffel, Victor, Lesner, Success, and many others. There is a demand for the best and most economical turbine that can be manufactured.

Turbines should be built to secure the delivery of the water upon the turbine without checking the velocity of the water more than one-third, to permit the free discharge of the same after passing through the turbine, and to work with as good efficiency under part gate as under full gate, and to be made of the best phosphor bronze, to stand the wear and tear under high heads.

It is essential in locating central stations to be run by water power, to place them where there is no great danger of a flood, or so protected by a breakwater as to make it perfectly safe, and also to avoid trouble with backwater upon the turbines.

Where a station is situated on the bank of a river it is best to take the water from the river by means of a raceway with the headgates parallel with the flow of the water, and at times of a freshet or running of anchor ice it will more than pay any expense incurred by so doing.

The raceway should be of a sufficent depth and width to permit the water to flow not more than 90 feet per minute, and a waste gate should be placed in the side or end of the race to use in case of emergency and when cleaning out the raceway. A rack should be built across the race to prevent driftwood and other rubbish from passing into the turbines. For that purpose I would recommend a rack built of iron slats two inches wide, one-eighth of an inch thick, and placed five-eighths of an inch apart on seven-eighth inch iron rods, at an angle of 45 degrees. Particular attention should be taken to keep the rack clean by raking. A trough or platform should be placed over and immediately back of the rack to rake the rubbish and anchor ice into, and so arranged that a current of water from the race will pass through the trough and carry off all the rubbish, etc. For any station that is using 100 h. p. or over it will be a great saving in labor to them and pay well for the extra expense. For winter service a boom should be placed in front of the headgates, and the current will carry off a large portion of the anchor ice and other floating objects.

The headgates should be built to work with a rack and pinion; also a roller should be placed back of each gate stem to facilitate the handling of the gate.

The gates should have a protection built over them, to protect the gearing from the storms. In a cold climate, where the gates are apt to be frozen in, salt is essential in freeing them from ice. All headgates and timbers should be of the best quality of oak, and should be well bolted, and not less than two gates to one raceway. The tail race should have not less than two or three feet of dead water when the wheels are not in motion.

Where the tail race runs under the station cement floors should be laid to prevent moisture in the station; a floor of that material will soon pay for itself.

Vertical turbines should be placed so that the steps are covered with water at all times. In adapting turbines to very high heads, or to conform to location, it becomes necessary to set the turbines above tail water and conduct the water away from the turbines through a draught tube. The same depth of pit and area of discharge is required where a draft tube is used as would be when the turbines are set at the bottom of the fall. The mouth of the draft tube should always be submerged about six inches in standing tail water. It is claimed that draught tubes can be used 30 feet in length. I do not think a draught tube more than 18 feet in length should be used on account of the difficulty in keeping the tube air tight, for if the tube leaks the vacuum is imperfect and there will be a great loss of power, and where steps are used they will be apt to be burned out.

When possible, I would advise horizontal turbines to be used, as they are easier taken care of, and many of them are used without any steps. The burning out of steps is an expense and an annoyance. One of the greatest advantages in the horizontal turbine is that the dynamo can be belted directly to the turbine shafting, and is in some cases coupled directly to the turbine, making a good percentage in economy in power and avoiding the use of gearing, and I deem it advisable to put in a number of small turbines, instead of one large one; in case of a break down, they are more easily repaired and cause less delay to customers.

In the old station of the Brush Electric Light Company, of Rochester, the vertical turbines caused considerable annoyance in the burning out of steps and stripping of the gears; so much so that it became necessary to support the vertical shafting with water cushions. For wooden steps we have had the best success with lignum vitæ.

In my opinion, governors for the turbines are necessary and will govern any slight variation of load under high head; but where one-third or over of the load is thrown off or on suddenly, it is necessary to handle the gate by hand, as under the above circumstances the turbine is apt to slack down or run far above the normal speed, as the case may be; in the latter case causing the burning out of lamps and armatures. The governors should be placed as near the turbines as possible to save lost motion in the gate shafting and avoid the use of gearing as much as possible.

We have two governors in use in our office building under a low head of 16 feet, and they govern the turbines under all circumstances in quite a satisfactory manner.

The decided advantage of a water power station over one run by steam power is not only one of economy in the saving of the expense of coal, but the station and apparatus can be kept cleaner and cooler, thereby saving considerable in expense of repairs, and it is also far more pleasant for the employés.

The Brush Electric Light Company, of Rochester, purchased the entire lower falls of the Genesee River (which is about two miles from the business centre of the city) some nine years ago. At that time it was looked upon by many as a piece of folly to think of running dynamos there, on account of the distance from the business centre of the city and the dampness around the falls. Notwithstanding the adverse opinions, they erected two buildings on the west side of the river above and near the brink of the falls, and put in two 30½ inch Leffel, two 20-inch Victor and one 40-inch Leffel turbines, the first four mentioned turbines, under 94 feet head, and the latter under 28 feet head, with a total of 2,500 horse power. After running this power for five years they built a new station and leased their old power to different parties for pulp and flour mill purposes.

The new station is a three-story stone building, 45 feet wide and 90 feet long, with a two story-brick addition 42 feet wide and 80 feet long, and located at the foot of the falls on the east side of the river. The turbine capacity consists of 15 double 15-inch horizontal Lesner turbines under 30 foot head, with 14 foot draft tubes, a total of 3,360 h. p., using 6.95 cubic feet of water per minute per horse power; have had but one turbine damaged to any extent in four years. The turbine casings are placed on iron girders with the ends of the girders resting on solid rock.

The amount of floor space occupied by all of the turbines is 4 feet × 38 feet. The weight of each turbine is 196 pounds, less than one pound to a horse power. Each turbine is placed in a separate division of the casings and the shaftings extend through the shafting room, upon iron bridge trees, with 7 feet and 6 inches between journals, and the dynamos are belted directly to the turbine shafting. The shafting runs at 800 revolutions per minute, with 25-inch pulleys on the turbine shafting and 24-inch on the dynamos. We use untried beef tallow for lubricating and are well satisfied with its results. The turbine gate shafts and governors are placed in the dynamo room at an average distance of 14 feet from the turbines, where they are easily handled by the attendants. A tell tale is placed in the shafting room, connected to a float in the race above the falls, which shows the height of water in the race at all times.

The water is taken into the raceway about 80 feet above the falls. The race is 32 feet wide and 5 feet 6 inches deep, and cut through the solid rock. There are four headgates with a house built over them. A wooden diagonal rack is placed in the race near the spillway to assist in freeing the race from anchor ice. The spillway is 6 inches deep and 32 feet long. The waste gates are placed next to the spillway, and are 3 feet 6 inches wide; there are two of them. In front of and near the top of the penstocks an iron rack is built according to dimensions given, also a rubbish trough.

There are three iron penstocks 6 feet in diameter and 80 feet high, built of three-eighth inch boiler iron, with a gate to each penstock.

There are five elbows to each penstock leading to as many turbines, with an iron slide gate to each elbow; in addition, each turbine has a register gate, thereby permitting the repairing of any one turbine without interfering with the running of the others. A turbine can be taken out and another put in its place in 25 minutes.

Cement floors are laid in the shafting and turbine rooms.

There are three tail races extending under the entire length of the main building; each race is nine feet wide and six feet and six inches deep.

As a reserve power, when making repairs and cleaning the raceway, we have a 600-h. p. Cooper Corliss engine; in the past year it has been necessary to use it but a few days.

For fire protection, two-inch iron pipes are run from the penstocks through both buildings with four lines of hose attached at all times. The hose is tested once a week In addition to the hose, a dozen fire pails filled with water and placed in different parts of the station are kept in readiness, and are not permitted to be used for any other purpose.

A record is kept of the time of starting and stopping of each turbine, also the speed and load on same, and any variation in height of water and all repairs that are made. In addition to the above records, the day and night wheelmen report the condition of the power at the time they are relieved.

There are nine men employed at the station, five of them in the dynamo department and four in the water power department.

We have in service 30 dynamos; three of them are run without any stoppage and the balance of them on an average of 13 hours per diem.

A record book is kept in the dynamo room, in which entries are made of the time of starting, stopping, speed and load of each dynamo, also all repairs of every description, all accidents to either machinery or circuits, nature, time and cause of same.

All the circuits are tested five times daily, and the tests and time of same entered in record book.

By the means of water power the company is enabled to furnish cheap and satisfactory light and power at the following rates, viz.:

City arc lights, all night and every night, 27 cents per night; commercial arc lights, all night and every night, 40 cents per night; commercial arc lights, evening, 25 cents per night; commercial arc lights, evening and all day, 40 cents; one-eighth h. p. motor, $18 per annum; one-half h. p. motor, $48 per annum; one h. p. motor current, $72 per annum; two, four and six h. p. motor current, $50 per annum per horse power; 8, 10 and 15 h. p. motor current, $40 per annum per horse power; one eighth h. p. fan motors, $15 per season, from June 1 to Oct. 1; 16 c. p. incandescent lamps, $5 to $12 per annum; 25 c. p. Bernstein lamps, $12 per annum; 50 c. p. Bernstein lamps, $24 per annum; 100 c. p. Bernstein lamps, $48 per annum.

The rates I have mentioned are for arc circuits; our rates for current on 500-volt constant potential circuits are as follows, viz.:

One h. p. $48 per annum; 2 h. p. $96 per annum; 5 h. p. $180 per annum; 8 h. p. $240 per annum; 10 h. p. $300 per annum; 15 h. p. $450 per annum; 20 h. p. $600 per annum.

We operate a total of 832 motors, of which 196 are fan motors, 1,396 arc, 135 Bernstein and 200 Swan incandescent lamps. One motor circuit contains 26 miles of outside wire and 394⅛ h. p. "C. & C.," one 2 h. p. and one 4 h. p. Brush motors, and is run with a No. 8 Brush arc dynamo. We have one 40 K. W. 500 volt "C. & C." generator in service, on an eight-mile circuit, with 48 h. p. in motors in use. The ammeter averages 29 ampères. We experience no difficulty in running same with our power.

The rebate for poor service during the year ending December 31, 1890, was one hundredth of one per cent. of the gross receipts, and the uncollected accounts for the same period was one-tenth of one per cent. of the gross receipts.

The Edison Electric Light Company have recently erected a three-story stone station at the foot of the upper Genesee Falls, on the west side of the river, and have at present two double discharge Leffel mining wheels under about 90 feet head, giving 600 h. p., and are placing two more of 400 h. p. each. In addition, they have a fine steam station in the centre of the business district. Incandescent 16-c. p. lamps are furnished at one cent per lamp hour; arc lamps for city use, 28½ cents per night; municipal incandescents at 6 cents per night. The latter they are partially replacing with arc lamps. They have in circuit 105 arc, 805 municipal and about 13,500 16-c. p. incandescent lamps.

The Rochester Electric Light Company's plant is situated at the upper Genesee Falls, on the east side of the Genesee River, near the business centre of the city.

The station is three stories in height from the top of the falls, with the wheel pit underneath, blasted out of solid rock 95 feet in depth. They have five Leffel horizontal turbines; four are 23 inches, and the other 30½ inches in diameter, with a total of 1,500 h. p., under a head of 86 feet and 8 inches.

The penstock is a steel pipe 7 feet in diameter. The power is transmitted to five shafts 80 feet above by belts 173 feet in length, running at a speed of 7,200 feet per minute.

The dynamo room is directly over the shafting, from which all of the dynamos are belted through the floor. The dynamos are the United States system.

They have in service 325 city arc and 140 commercial arc lamps; also 1,500 incandescent lamps, and two 10-h. p. motors. They have just placed one 85-h. p. generator and one 1,500 light Westinghouse alternating dynamo.

As a reserve power, they are putting in a 400-h. p. engine. The city lights are being furnished at 27 cents per light.

In addition to those I have mentioned, there are five incandescent plants and one arc isolated plant run by water power in Rochester, some 500 incandescent and 25 arc lamps, making a grand total of 1,991 arc and 16,640 incandescent. The population of Rochester is 135,000, making a very high average per capita.

Mr. REDMAN: With regard to motor rates no distinction as to the business is made unless the power is used for ventilating purposes. Where a one horse power motor is used for ventilating purposes we get $120 for its use.

Mr. FRANCISCO: Do you make any difference with regard to the time the motors run, or is this for constant service?

Mr. REDMAN: It is for constant service. The customer can use it or not.

Mr. FRANCISCO: You do not use any meter with these?

Mr. REDMAN: No meter.

Mr. FRANCISCO: We charge the same rate for light and power—25 cents per thousand watts. But we have found in respect to its use for power that there is a vast difference in the kind of business in which the power is used. We are running a motor for a daily paper. They used to run that paper with water power and a steam engine, and it took them four or five hours to run off an edition of the paper. When we started in they supposed that it would take the same length of time to run off the edition with our motor as it did with the water motor and the engine, and we based our contract on that supposition. They have found since they put our motor in that it requires just one hour and ten minutes to run that edition through instead of four or five hours. Our contract, however, was based on the experience which they have had with the water motor. They only used the motor while that edition is being run off—for the one hour and ten minutes—whereas, in another class of business, as in running an elevator, they will run the motor through ten hours of service. In one store they are running a passenger elevator, a freight elevator, a cash system, and a coffee grinder—all with the same motor, and they are running it for ten hours in that store. They run it under a contract. If we charge for horse power so much for ten hours' service, of course in that case we would lose, whereas, in another case, where we charge by the horse power,

the motor might not be in service half the time. So you see that there is a vast difference in the employment, so far as the motor business is concerned. We are also running a freight elevator in a store, which is run on a meter. We charged $60 per year for a 5-h. p. motor, and we found that by the record of the meter this was just three times the meter rate for the same service. I find that as to other classes of business it is the same. I find that a job printing office is one of the very worst places for motor service. You cannot run motors in different classes of business for the same price per horse power. I am referring of course to steam power. If you have water power it is quite another thing. That is why I am anxious to get out all these points, and why I want to know whether it is calculated upon a ten hour service, or upon the ordinary run of business. In the case mentioned I am getting just three times as much from the contract as I would get on a meter. But still I would rather have the meter, because if a meter is used you know just what you are doing. You know that the man is paying for just what he is using, and for no more. Then you can make your calculations on your business. You know that you are giving him a legitimate and straight business, and the man will be satisfied to be charged by the meter. We are running a motor simply for a passenger elevator in one building where there is a bank and offices. It is a four-story building. The man would not take a meter. He said that he wanted to know definitely just what he was to pay per year, and so we made a contract with him by the year, charging the regular price on the contract basis. I have since then taken some little pains to find out how much they are using that elevator. It is a small passenger elevator, will accommodate four or five persons, but it is very seldom that there are over three persons in it at any one time. He had a 5-h. p. motor to run that elevator. That motor has not been used on an average one hour per day. Still we are getting the price for a continuous service—$60 per horse power per year. I asked him to let me put that contract on a meter, but he did not want a meter, but wanted a definite amount stated. Now, suppose that you are running that elevator at so much per horse power, and are running a Daniels planer at so much per horse power. The elevator will take three or four ampères, while a Daniels planer will take 40 ampéres. The elevator is running one or two hours per day, while the planer is running ten hours per day. You see at once that there is no chance for making the same tariff on that class of business run in that way. But in considering our rate of 25 cents per thousand watts it must be remembered that we are running on steam power where coal costs us $4.50 per ton. The entire installation is under our care. Everything that is required we have to do. The customer buys the motor, then we keep it in repairs.

Mr. Wilmerding: If we could get at the rate of 25 cents per thousand watts we should prefer the meter, but I have found the meter system unsatisfactory, because the character of the service varies so much. Our charge for elevator service is from five dollars per month to fifteen dollars. That is on the basis of ten cents per thousand watt hours. On our contract prices we make three rates. We have a rate for continuous power, a rate for intermittent power and a rate for elevator service. For the elevator service we charge $5 per month per horse power, or $60 per year. That is for any kind of elevator service. But I have never found that any of those elevators when run on the meter show more than one-third of what our contract price would give us. I have also found that our customers are more surprised than we are at the small price that they have to pay for the service. For that reason I have concluded recently that we will not furnish any elevator service on the meter system. We do not want to surprise them in that way. Our coal costs $2.65 per ton, but we are using compound condensing engines, and our indicated coal consumption is not more than two pounds per horse power hour.

Mr. Ayer: There has been nothing said here with reference to constant current rates, and it may perhaps be of some value to some of us to know what the charges are in that way. We are running more than 200 constant current motors on arc light circuits, and we make a charge of $10.50 for a single horse power for ten hours service, regardless of the character of the service. Wherever we happen to have a variable load that indicates that the load on those motors is the maximum load, and we insist on their making a contract based on that maximum load. If we find them bringing in additional machines later, our motor inspector is very apt to find it out, and we soon know just what they are doing. We find no difficulty in making satisfactory arrangements on that basis. We find that on constant current motors the price has been satisfactory, and we have had no difficulty in making our contracts on motors at $10.50 per month per horse power. For 3 h. p. and upward we make the rate at $8.50.

Mr. Wilmerding: I do not want to be understood as saying that we make a five dollar per month rate straight through, but that is on elevator service. Our lowest contract price for the intermittent service is $8.25, and our lowest price on constant power is $9 per month.

Mr. T. Carpenter Smith: I would say that there is one advantage that a constant current motor has over a constant potential motor, and that is that a constant potential motor will slow down if it is overloaded.

Mr. Scott: The point that interests me is the relative cost of the production of power by water and by steam. The charges to customers, although very interesting facts, can be got from the schedules. The charges to customers have been, according to my experience, regulated with what the customers were willing to pay for the service. What we central station men want to know is how we can produce a good article at the least possible cost. We come together for the purpose of deliberating upon what are the best methods for us to pursue under different circumstances. From what I have seen in my own section of the country I judge that water power has not superseded steam. The companies there can run with high pressure engines and furnish a 16-candle lamp per hour at an expenditure of half a pound of coal, whereas water will cost them as much as six-tenths of the cost of a pound of coal; and when water costs them that much they are not going to discard steam for water. I do not find in this paper a statement of that element of cost. The paper speaks of the rebates costing only one one-hundredth of one per cent. The rebates do not cost us that, as we only give rebates back to men who kick so outrageously that we cannot get rid of them. It costs Mr. Redman something to keep up his raceway, and it costs something to repair dams. There is no water power that is proof against damages by floods. Then there is the expense of cleaning out his pond. If those repairs, and the wages of the men who are delegated to make those repairs, cost as much as buying a load of coal, why should we not buy the coal? I want to get at the facts which will pay us to throw out the coal and take in water. I never take any water in mine when I can help it.

Mr. Leonard: I have had some experience in connection with the running of stations by water power, and I think that the remarks of the last speaker are very pertinent and very correct, and that the cost of water power, although it is apparently cheaper than steam, is frequently higher than it would have been for a first-class steam plant. I think, further, that water power is really not sufficiently constant to entirely eliminate the steam plant. With the exception of a few plants where the water power is peculiarly favorable, the water power has to be assisted by a steam plant, and the ultimate expense is frequently higher than it would have been if the company had entirely disregarded the water power and built the steam plant at the best possible location. In my own experience I find that the best use to make of water power is not that of operating a full load, but of taking care of that portion of the load which is quite light, and which operates between, I will say, 11 o'clock at night and dawn of the next day, for the load is fairly constant during those hours, and the economy of the water power is then more marked because it enables the services of an engineer to be dispensed with. The use of the water power has proved to be very economical in certain places where a not very reliable water power existed, but where perhaps 50 or 100 h. p. could be obtained at almost any period of the year, and which would answer to carry a light load during certain hours of the day and late at night.

Mr. T. Carpenter Smith: I would say that this question of the relative cost of steam power and water power has been very fully considered in some papers which were read before the American Society of Mechanical Engineers, and notably in a paper read last year by Mr. Manning, of the Amoskeag Mills at Manchester. He states that his experience has led him to the conclusion that all things considered steam will, under almost any conditions, if properly handled, be produced as cheaply as water power. I think that at most central light stations the best use to make of the water power is to use it in condensing. Steam has an enormous advantage over water power, in that with steam you can state almost to a certainty just what your power will cost you. There has been such an enormous experience in steam, and so many statistics have been collected, that the cost per annum per horse power of steam has been determined within very small limits for all the types of engines in use. With water power, on the other hand, the contingent expenses are very likely to far more than offset the original cheapness of the water power. If a steam engine has really to be installed anyhow as a relay to the water power, you might as well run with steam all the time, for you have got to keep the engineer there, and you have got to keep the fires ready for lighting. And further, a steam engine possesses the ability to be driven beyond its rated capacity, whereas your water wheel is absolutely limited to the power contained in the head, and in case any sudden call is made for increase of power you must either shut down or start your engine. And if you have to keep your engine ready to start up it is better to keep it going the whole time. I wish to say that I would strongly recommend all members of this association to secure those papers, which can be had by applying to the secretary of the Society of Mechanical Engineers. Another paper, which was read some years ago by Mr. Louis F. Lyon, on the use of headlight oil for keeping boilers clean, is also worthy your attention. I read that paper and tried that oil, and had such success with it that we have used it ever since. But, of course, the oil must be used intelligently, and I have found the method given by Mr. Lyon to be the best. We have tried it in several different ways, but find that his method is practically the best. Those two papers, I think, are well worthy the attention of the members of this association.

The President: If Mr. Moore, the representative of the Quebec company, is here we would be glad to hear from him. Although he is not a member of our association, we shall be glad to extend the courtesies of the association to him. I know that he can give us a very interesting statement in regard to the Quebec water power. I know that he is in the city, but he does not seem to be present.

Mr. Armstrong: I move that the further consideration of this paper be postponed, and that when Mr. Moore comes in he be invited to speak upon the subject.

The President: We will take up another paper now, and if Mr. Moore comes in we will resume the discussion of this paper.

The next paper, that of Mr. H. Ward Leonard, of New York, entitled "A Central Station Combining the Advantages of Both the Continuous and Alternating Current Systems," was then read and is here given in full.

A CENTRAL STATION COMBINING THE ADVANTAGES OF BOTH THE CONTINUOUS AND ALTERNATING CURRENT SYSTEMS.

By H. Ward Leonard.

We are all well aware of the fact that the greatest strength of the three-wire system is due to features the lack of which constitutes the greatest weakness of the alternating system, and that the reverse of this statement is equally as true.

The high efficiency, reliability, safety and adaptability to supply almost any requirements for electric energy, which are the features of strength of the three-wire system, are the very points upon which the alternating system suffers by comparison, for its efficiency is much lower, its reliability is less, due to the fact that its machines are not practically operated in multiple arc, its safety is necessarily less, due to the existence of the high primary pressure, and its current is not adaptable to commercial use for motors, charging storage batteries, electro deposition, and so forth.

On the other hand, the low first cost of an alternating system, the simplicity of its circuits and of the operation of the central station, and its ability to reach, with moderate expenditure of capital, lighting at any practical distance, make it the only possible pioneer in new and untried territory without great risk and almost the certainty of expending capital which will never be remunerative.

Hence it is that we find the three-wire system in possession of the densely settled centres of cities and towns, and not extending to the outskirts because of the uncertainty of a sufficient return upon the necessary capital, and both the central station manager and the distant, would-be consumers anxiously awaiting the development of improvements which will enable the three-wire central station to supply such distant consumers. And hence it is that the manager and consumers of an alternating system anxiously await the day when motors can be operated, and a more economical, safe and reliable current than the present alternating current can be furnished by such a station to supply the imperative wants of the heart of a busy city.

If the above statement of the present existing conditions be a fair one, it will be evident that if we could only in some way secure the advantages of both systems in a common distribution, we should greatly improve matters. The object of this paper is to point out what appears to the writer to be a step forward in that direction.

The following conditions seem to be necessary:

1. We must supply a continuous current for the central portion of a town during the daytime when power is required.

2. We must supply the outlying districts with an alternating current during the night time when lighting is required.

3. We must not operate the alternating system under conditions of light load when its efficiency is very low.

4. We must be able to supply current for lighting continuously throughout the 24 hours of the day.

5. We must have but one set of conductors in any consumer's place.

In order to meet the above conditions I propose the following:

1. Wire all consumers upon the standard three-wire system.

2. Connect all consumers upon standard three-wire main.

3. Arrange the network of mains so that the central section of the network can be disconnected from the outlying sections through the agency of switches.

4. Install three-wire feeders to supply the central portion of the systems at full loads, and install 1,600-volt primary wires and alternating current converters with a three-wire secondary circuit to supply the outlying section at full load.

Let us see how we will operate the station: Suppose it is 8 o'clock in the evening. The switches which serve to connect the central and outlying sections are open, and our three-wire plant is supplying the full load of the central portion of the city. The alternating plant in the same central station is supplying the converters of the outlying section, which converts from 1,000 volts primary to 220 volts in the secondary, and the secondary coil has a connection at the centre which is led off to supply the central wire of the three-wire system of the outlying section, the outside terminals of the secondary being connected to the outside wires of the three-wire system. It will be noticed that both plants are being operated at full load.

Now, suppose it to be eleven o'clock. The load has gone off rapidly so that the alternating plant is now operating under the worst possible conditions, and these conditions will continue for the outlying district until dusk the next day—that is, for probably 18 hours. An operator is now sent out who goes to each section supplied by a converter, and by throwing a switch transfers the secondary wiring from the alternating system to the three-wire mains. In this way the small remaining load is gradually transferred to the three-wire plant, and then the alternating plant is shut down. The three-wire plant continues in operation all night and all the

next day, supplying all devices with a continuous current. Motors can be operated in all portions of the system, even for domestic purposes in the distant residences, and all consumers get the opportunity of the use of the continuous current for any purpose desired for 18 hours out of the 24.

Dusk now arrives and soon the heavy lighting load will rapidly come on, and in such case the outlying section could not be supplied by the small wires feeding the distant three-wire section during the day, which are only about one-tenth the size which would be necessary to supply the full load.

The operator again goes round the circuit and now transfers the load of the outlying section from the three-wire plant to the alternating plant, and this condition prevails again until 11 o'clock arrives, when the operation is repeated, as before described.

The switches for transferring the load of the outlying section from one system to the other can readily be controlled by simple means from the central station itself, if desired.

Now let us look at some of the advantages we have gained:

All of our inside wiring is done on the three-wire system for use of a lamp of 110 volts. This means that for the same distances and loss in conductors we will save eleven twelfths of the cost of copper which would be required by a secondary using 55-volt lamps upon a two-wire system, or, to put it another way, we can supply 110-volt lamps upon a three-wire system with the same cost of copper and the same percentage of loss in conductors at three and a half times the distance which would be permissible for 55-volt lamps on a two-wire circuit.

We all know the great desirability of using large converters, on account of their cheaper first cost per lamp and their higher efficiency, and also because a far more perfect regulation of pressure can be obtained upon a lot of lamps scattered in different kinds of stores throughout a block, if they be supplied from one converter, than can ever be obtained by supplying these lamps by a lot of small converters loaded differently in almost every case, and consequently supplying a different pressure at the secondary terminals of each converter.

Under the system proposed by me one converter would ordinarily supply the entire lighting of a block, resulting in less first cost, higher efficiency of conversion, longer life of lamps, greater reliability and greater simplicity of plant.

A point worthy of notice is that for 18 hours out of the 24 an absolutely safe pressure is in use throughout the entire system, and that during all daylight hours when the greatest liability to accident from contact with high pressure wires exists, no high pressure is in use.

With such a system no consumer need be turned away.

The consumer who wants to charge storage batteries, and also make electric welds by electricity, can do so upon the same day and from the same wires that supply his incandescent lamps.

The factory upon the outskirts of town, which runs its isolated plant, and must to-day either use storage batteries or run machinery all night to supply a few watchmen's lights, can now switch on to the central station at six o'clock, and operate the few lamps it may need until dusk next day, when heretofore the alternating system, which was the only one which could reach it, did not run after midnight, or possibly after daybreak, because of the loss of money in so doing.

With this system the outlying districts can be pioneered with the least first cost and least risk. Any outlying section in which, for any cause, the demand increases greatly beyond that originally anticipated, can be supplied permanently by the three-wire system by merely running the necessary feeders to supply the already existing mains, and in such case the switches and converters would be moved out further or transferred to some new section ready for pioneer work.

The combination of a storage battery system and an alternating system also presents peculiar advantages. The storage battery is at its best when supplying a small steady load, such as we have for at least 16 hours out of the 24. The alternating is at its best when supplying the full load possible only during the remaining eight hours. The average electrical load on a general system is only about 12 per cent. of the maximum, consequently we are entirely safe in the statement that the greatest load during the 16 hours of light load is not more than 10 per cent. of the maximum load for the 24 hours.

If we were to attempt to operate the heavy load by storage batteries, we must either make an enormous investment, or, what is even worse, operate storage batteries at a disastrous overload. On the other hand, if we try to operate the 16 hours light load with converters, our efficiency, when operating at 10 per cent. of our converter capacity, would be unmentionably low. But reverse the case and everything works at its maximum efficiency. During the eight hours of possible heavy load, we operate all devices by the alternating system. At the same time a continuous current dynamo charges our storage batteries located either in the central station, or, if more desirable, at different centres in the system of distribution. At the end of the eight hours' run we shut down the plant, lock up the station, and leave it for 16 hours, the storage batteries meantime supplying all devices.

If, for extraordinary reasons, we have not capacity sufficient in the storage batteries to supply the demand, we run the continuous current plant to assist it; and if that should fail or prove insufficient, we start up our alternating and supply all or a disconnected part of the system with it.

With this plant distances are of no consequence; we can use 1,000 volts for the continuous current plant as well as for the alternating, and the single two-wire distribution is all that is necessary for perfect results.

The weak spots of this latter arrangement will, no doubt, be thought to be the storage battery, but my experience with this device is that if you use it properly under suitable conditions, and do not attempt to squeeze impossible results out of it, economical and satisfactory service can be obtained from it, and certainly no better conditions could be obtained for it than those described above.

Up to this time a bitter fight has waged between those believing that the alternating, the direct, or the storage battery system, respectively, was the only suitable one.

I believe in them all, each operated so as to be used under the best conditions for its use, and I trust that the suggestions given above may lead to our being better able to meet and overcome our common enemies—high first cost, low efficiency, danger, unreliability and the inflexible conditions of the existing demand.

Mr. T. CARPENTER SMITH: I am afraid that in rising to speak upon this paper my audience will understand pretty well what ground I am going to take. I wish to begin by remarking that history has told us and has repeated its story, over and over again, that no state, no municipality, no corporation, nor any individual can afford to defy public opinion. It may seem to do so successfully for awhile but it must ultimately be crushed by public opinion, which, if it be leaden footed, is also iron handed. I think if there is one feature in our business which has been overlooked, it is the relation with which we are most concerned, and that is the relation which it bears to the public. We have been accustomed to speak of the efficiency, the reliability, the safety, the easy adaptability of any of the various systems in use, only with reference to the relation that those features bear to the central station itself. The consequence has been that all currents using high tension have almost without exception in the first years of the business been installed in such a manner as to be a serious menace to life and property, and therefore have been universally condemned by the unitiated public. I wish, therefore, to say that whatever remarks I may make are based upon the relation of electric lighting to the public, and not its relation to the central station. With that statement as a starting point I wish to join issue at once with Mr. Leonard in his statement that the alternating system suffers by comparison with the three-wire system, "for its efficiency is much lower, its reliability is less, due to the fact that its machines are not practically operated in multiple arc; its safety is necessarily less, due to the existence of the high primary pressure, and its current is not adaptable to commercial use for motors, charging storage batteries, electro deposition, and so forth." I will start out at once with the first of these—as to its efficiency being much lower—and will say that the efficiency from the standpoint of electrical engineering, the average efficiency during the 24 hours load, the converter system as at present installed may be lower than that of the three-wire system. But with regard to the satisfaction of the public, I think that the efficiency of the alternating system is considerably higher. I have been operating now for nearly four years an alternating system, and we supply 3,000 lights in a district of the area of six city squares. We cannot go any further because we cannot get a franchise. Our district is honeycombed by the three-wire system. Their central station is within a block of us. Their wires run down every block on which ours are found, and on some blocks where ours are not. They have connections in nearly every building in that district, and yet they have never succeeded in taking a single light from us. On the contrary, we have taken several customers from them, simply on the ground that their customers could not stand the poor regulation. The sudden changes in the light annoyed customers so much that they preferred to come to us. We have never lost a customer from bad service. We have thrown several off, but we have never lost one. Mr. Leonard says that "its reliability is less, due to the fact that its machines are not practically operated in multiple arc." I do not think that that amounts to anything, and for this reason: That while their machines are not generally operated in multiple arc, still they can be, and if there were any necessity for it they would be so operated. I do not think there is any necessity for it, and I prefer not to do it, because I think that in case of accident to any one machine there is far less danger of accident to others. Any one machine being broken down does not give you the risk of breaking down other machines running on the same circuit. The time required to throw in the switch of a relay machine is not more than the time which is required to throw in the switches which Mr. Leonard uses for transferring from one system to the other. In actual practice that simply amounts to the winking of the lights for one instant. Another advantage and one in which safety is also concerned, lies in the fact that the alternating system has its load divided up into small units. That is to say, no matter how badly the wiring may have been done in any one building it does not affect any other building, and one customer cannot threaten the safety of every other customer of that station by having his apparatus or the wiring in bad condition. The failure of one group does not affect any of the others. The alternating current in itself, from the mere fact of its being an alternating current, has an immense added safety in the fact that it will not strike an arc. It is difficult to follow an arc with it except under very high pressure. We have had that illustrated over and over again in lamps under conditions where a 50-volt direct current would cause the blowing of the fuse. A very serious question which was brought before the committee on safe wiring is one that we have got to face before very long and to consider seriously, and that is the grounding of the neutral wire. There have been several arguments brought forward why this should be allowed. It practically came down to this, that the insurance agents and inspectors have preferred to ground the neutral wire, and practically make a return to the one-wire system of installing electric lights, to avoid the much greater danger of the 220-volt arc between outside wires, and the consequent damage in buildings where combination fixtures are used. Now I do not know whether it is not a good thing to go back to the one-wire system of wiring. That is an engineering question that we shall have to determine by years of experience. But I do know that if the grounding of the neutral wire is permitted, you must also permit the grounding of the transformer. You cannot make fish of one and flesh of the other. And more than that, I do not believe that is the real reason of the desire for the grounding of the neutral wire, but that it is rather due to the fact that any failure of the third wire would cause the blowing out of the lamps one side, or the other, according as the load may be placed. That objection would equally apply to Mr. Leonard's plan of wiring up all lights on the three-wire system. I think that the inherent defects of the three-wire system are enough to forbid its use. The two-wire system will meet these conditions. You can do your wiring on that system, if you please, on 100 volts—although I think myself that the lower voltage we get and the larger the conductors we get, the better safety we get—and the slightly additional cost in installation is generally borne by the consumer. The statement that with large converters we get cheaper first cost, higher efficiency and better regulation of pressure, I fully agree with. I will speak of that later on when I come to point out the method of alternate distribution which I think meets all the points that Mr. Leonard desires. The statement that the safety of the alternating current is necessarily less, due to the existence of the high primary pressure, I beg to deny. The three-wire system in use gives an absolutely continuous metallic contact from dynamo to lamp, from street main to lamp, and from every lamp on a circuit to every other lamp on that circuit. These three-wire systems, finding that they could not operate their street circuits with any economy, have installed high tension machines, carrying considerably higher voltage in many cases than the ordinary alternating system. It is very evident that the first contact between that high pressure wire and the street main at any point, however slight it may be, puts that high tension on every lamp on that circuit. To do that with the alternating system you have to break down the insulation of every converter. Personally I have never known of a case of contact between the primary and secondary coils of a converter. I know that such have occurred, but I do not think that there has ever been one worth considering when we think of the enormous number of converters that have been put into service, the immense strides that have been made by the alternating system, and the small knowledge we had of it when we first started to install it. These are accidents which will teach us lessons, but which should not lead us to a condemnation of the new system. The high primary pressure we must have, no matter whether we use the continuous or the alternating current. We cannot carry the current without it. It is exactly the same as with water pressure or with steam pressure. Twenty years ago 50 pounds was considered high steam pressure. To-day 80 pounds is the average. I do not think that of the new boilers that are being installed less than 25 per cent. are being put in for a pressure of less than 150 pounds, and in 10 years 150 pounds of steam pressure will be used where 80 is now used, and 200 pounds where 150 is now used. We know that in all new stations that are being installed, in all new plants where steam is being used for power the constant tendency is to raise the pressure. It is kept safe simply by the addition of proper precautions due to the increased pressure. The statement as to its current not being adaptable to commercial use for motors so far would seem to be proved, but four years ago that same argument was brought forward—that the current could never be used for meters. I think that the alternating current meter has pretty well fought out its own case and worked out its own salvation. I do not think that to-day there is any direct current meter on lines in which they are in use which can compare with the meters which have been brought forward as the direct result of the introduction of the alternating system. I therefore think that in a few years we shall see the motor in the same way. We do have a demand, however, for power, and so far we must admit it that the alternating motor, except in small sizes, is not well adapted for use for certain central stations although it is of great use in isolated installation. I think, however, the experience of every central station is that it is better to have separate circuits for power and for light. And I think that this plan will meet fully all the requirements of the central station, and that you can use the alternating current for your lighting and the continuous high tension constant potential circuit for your motors. That constant potential circuit can also be used for charging storage batteries and for any of the other purposes for which the direct current is used. The safety to the consumer by the use of converters is not only limited to the accidents from the motor itself, but it also has its value in the case of light installations. Not long ago there was a discussion between the advocates of the direct and of the alternating currents at which one of the advocates of the direct current called attention to the fact, and gave it as a warning against adopting it,

that the converter was simply a good lightning arrester to protect one company at the expense of the other, and one alternating current advocate present had the good sense to rise at once and thank him for the advertisement. I do not think that there is any stronger argument which you could use for its adoption. The people who are operating stations presumably know what they are about. They know that they are handling a dangerous element, and they will take care of it. Their employés should be well instructed, and then if an employé is injured it must be due either to his own carelessness or to those accidents which must to a certain percentage always happen. I think when you sum up the disadvantages of the alternating system you will bring them practically down to one, and that is poor efficiency on low loads. To meet that a system must be devised which will have all the advantages of the alternating system, and which will have an efficiency practically the same at high load as at low load. At high load I think that the efficiency of the transformer system is as nearly perfect as we are likely to get it. The further improvements will come in by the use of better material and of greater care in manufacturing. With these improvements I think it will pretty nearly reach the theoretical advantages. The 1,000-volt primary current which is in ordinary use is not high enough for large cities. Ferranti uses 10,000 volts, and has been operating under that current for several months, and with apparently great success. I think there is no doubt that the time must come when we will use higher pressure than 1,000 volts at central stations, and then get right out in the outskirts where we can have cheap fuel or water power, and from there send into the city under high pressure the whole current, taking off nothing on the way, that we will have sub-stations where the current will be reduced from very high pressure—which must not be handled at all—to a lower pressure midway between the generating pressure and the distributing pressure, and with that we can supply the districts. In the sub-station it will then be possible to install three or four large converters, or any number that may be required, connecting them up in multiple arc, and then when the load gets light, instead of changing over to another system we will simply cut out some of those converters on both ends, leaving only fully loaded converters to carry the load. This, of course, is open to the objection that it requires the presence of an attendant, but devices have been and are in operation in England whereby that change is made from the central station by means of automatic switches which can throw in one, two, three, four or five of those large sub-converters. I do not believe in the use of small converters. I think the larger you can keep your converters the better, but yet we have to weigh very carefully the disadvantage of having too few lights on one converter and too many lights in one group where by grounding of one part of the group you may affect the safety of another part. It is between those two limits that we must fix upon our most efficient size of converters. In figuring up the size of blast pipes used in our large rolling mills, and in the size of water mains, that question is continually coming up, and the limits on one side are the interest on the extra money expended in the first place and the loss by friction, or by resistance, or by pressure, or whatever it may be. The use of the two systems in this way, by keeping all the customers continually wired up upon an alternating system avoids great danger of connection between your high tension wires and your low tension main. If your low tension wires get crossed with your high tension direct wires for the supply of power, the station may be hurt, but the consumer is not likely to be. Say what you will, it comes down to this—that it is the consumer who will regulate the running of your station. If he does not regulate it by legislation he will do it by hurting your business, by refusing to take what you supply under arbitrary conditions. And so we come back to the proposition with which we started—that no corporation, individual or government can say "the public be damned" and not suffer for it.

Mr. Leonard: Mr. Smith seems to have made the error of assuming that I am appearing in the rôle of an advocate of the three-wire system. If such impression exists I wish to correct it as promptly as possible. My remarks with reference to the three-wire system and the alternating were such that they would be admitted by almost every one to-day. I presume that any one familiar with the facts would admit that the average efficiency of the three-wire system was higher, that it was conspicuously higher at small loads, and in speaking of the possibilities and advantages of the system which I have proposed I was only giving consideration to the existing conditions of to-day. First, I will speak upon the points that Mr. Smith has mentioned, as I have noted them. He spoke of the disadvantages of operating the multiple arc system. And yet it seemed as though the universal opinion must be that a multiple arc arrangement of dynamos is preferable to a separate one when we remember that in the first part of the business of electric lighting, machines of constant potential were operated on separate circuits, and that they have been gradually placed in multiple arc is due to the advantages gained thereby. I think you will almost never find to-day an isolated plant where we have a large number of machines supplying a constant potential distribution, in which each machine is supplying a separate circuit. The possibilities of regulating and the economies are so much higher when the machines are in multiple arc that, entirely outside of any consideration of central station supply or of the three-wire system, it seems as though the result of experience has been that where machines can be operated perfectly, simply and reliably with multiple arc it is better to do so. With reference to the question of grounding the neutral wire: I can dismiss that by stating that I agree thoroughly with Mr. Smith that the grounding of the neutral wire is extremely bad practice, and that there is no argument for grounding the neutral except perhaps that of laziness. As to high pressure primary, the paper which I have read of course bears evidence in itself that I am a thorough believer in the necessity of high pressure primaries for reaching any great distance, and there certainly appears to be an advantage in having those high pressure wires as few in number as possible. And instead of having a complete network through the city of high pressure wires, if we can by any means carry a few of the high pressure wires to centres, there would be less liability to any trouble due to the existence of high pressures. Mr. Smith has mentioned that in his belief an alternating current motor will soon be attained in practice and ready for service. I thoroughly agree with Mr. Smith on this point, and have no doubt that an alternating current motor will soon be ready for commercial service—but how soon is a question. In the meantime the existing condition to-day is that the central station manager cannot secure an alternating current motor to put upon existing circuits, and, in fact, the work which is being done on an alternating current motor thus far is not of a kind to indicate that an alternating motor which can be placed upon the same circuit as an incandescent lamp will result. One point I will state before going further: All of my remarks have been on the basis of the three-wire system merely because of the saving in the cost of conductors which is attained thereby. Were we able to have a 200-volt lamp instead of 110 volts it would be, of course, infinitely preferable to have the two-wire system and use a 200-volt lamp than to have three wires for a lamp of 110 volts on each side, and, furthermore, the cost would be reduced even beyond that of the three-wire system. As to the sub-station method of operating on the outskirts of the town, that is unquestionably, when the alternating current motor is at hand, a very desirable way of operating. And yet it seems to me that even then until we have our 200-volt lamp it will be extremely advantageous to use for distribution something which will enable us to reduce the cost of our conductors on the consumer's premises to a point far below that of 50-volt lamps. As I have pointed out in the paper the cost, at the same distance and at the same percentage of loss in conductors of a three-wire system, will be but one-twelfth that of a two-wire system with 50-volt lamps, and if we had 200-volt lamps, with the two-wire system and our secondary distribution, it would be but one-sixteenth. Consequently when we have delivered our high pressure to the sub-station and are ready to distribute to our consumers, we would have a very large number of sub-stations in order to operate 50-volt lamps, or else we must have an enormous expenditure in conductors. It seems to me that under the existing conditions it will be well, and indeed the best way that we have at present at command, to use the three-wire system, as it does enable us to distribute from that centre at low pressure and at the least cost. When the time comes that the 220-volt lamp is commercial, the three-wire system will of course still present the advantage of being able to reduce the cost, but the high pressure which will be realized then may be a sufficient argument against the use of 500 volts in the premises of the consumer, and may make the 200 volts satisfactory.

Mr. Smith: I wish to speak first in reply, because I wish to straighten out a little matter between Mr. Leonard and myself which might interfere with the proper carrying on of the discussion afterward. I fully understand Mr. Leonard's attitude in this matter. My remarks about the three-wire system were not made with any idea that Mr. Leonard is upholding it as against the alternating, but because he in his new plan calls for all inside wiring to be done on the three-wire system for lamps of 110 volts. I apparently did not make it clear that the 200-volt direct current in the building is what the insurance people are afraid of now, and that consequently we must abandon that in any new system which is to be an improvement upon that. The use of an alternating current of 220 volts I do not believe would have that disadvantage, and in that case Mr. Leonard's plan would be all right. But as his plan contemplates using during a part of the time a continuous current of 220 volts, I feel that the 220 volts should be barred altogether. Of course on a 50-volt lamp we can use the three-wire systems, and in many cases where buildings have been already wired we may get a proportion of reduction of copper in that way. With regard to the multiple arc I would say that in my experience the multiple arc in isolated work has been used to save the running of new feeders. Where a plant has been wired up throughout and one dynamo installed, and then enough lights put on to take up the whole capacity of that machine, and the customer wants more light, he taps the wires which he has. But when he goes to put on new power he simply couples his new dynamo right into the circuit, just as a man who puts in a new boiler in a steam plant couples in the old steam pipe. If the old steam pipe were too small he would run a new main. And so it is with an electric light plant. Where we install an isolated plant we always put it so that three or four dynamos can operate, though as a general rule they are all in multiple arc. Another reason for operating a multiple arc system is found in the fact that small sizes have been hitherto made in machines. A thousand-light dynamo is just about as good for practical use, but we have 3,000-light dynamos for the alternating current, and larger ones are to be built and used. In that case I do not think that there can be any question about multiple arcing. With regard to sub-stations I would say that Mr. Leonard seems to have slightly misunderstood my remark. The sub-stations are not for the purpose of direct supply to the consumer. They are for supplying the sub-mains, which are run at much higher pressure than we would introduce to the customer, and the customer is supplied through a second series. That of course gives us the double conversion, and the loss caused by double conversion as against the loss caused by a single conversion; but it gives us the advantage of running one of those converters always at its highest efficiency, namely, a full load. The whole question, of course, as I have said, comes back to one of interest on first cost as against loss in feeders. So that in speaking of sub-stations I do not mean to be understood as saying that there would be an enormous number of sub-stations, but only one for each district.

Mr. Leonard: I think that Mr. Smith has made a very ingenious argument upon the multiple arc question, but I hardly feel that his position is sustained by the facts or by practice. Of course, as he has pointed out, where conductors are placed on one dynamo and the load gradually increased they are driven to the multiple arc arrangement unless they are going to put in new conductors. The fact is that every large isolated plant that I have ever had occasion to bid on has been so specified and rated by the common consent of all companies that have entered bids, that the dynamos shall be in multiple arc when there were eight or ten at the beginning, and it is the universal practice in all companies to so design their plants, and hence the multiple arc arrangement is one that has been forced by the unexpected enlargement of the plant rather than by a deliberate design to obtain the best results in the beginning. Mr. Smith has spoken of an arrangement of sub-stations, but he has not yet pointed out how he gets rid of the losses that will occur upon the final converters. He has put in an intermediate set of converters, and has taken means to take out converters as the load diminishes, but his final converters in his distribution throughout the city are still connected, and are the same as we have had before.

Mr. T. Carpenter Smith: I would use the same plan as Mr. Leonard proposes in his system. I would have them grouped and switched in and out by the operator, just as I do in the sub-stations. I am only comparing one system as against the other. With regard to the multiple arc, I will say that I still hold to my proposition that multiple arcing is not put in because it is a great advantage, but it is put in to allow of two machines being connected together. It is a good thing simply because in an isolated plant the conditions are different from what they are in a central station. Your loads are all on one side of the bus bar and you are required to run two dynamos separately, and it is similar to running them together in the same building. If you take an ordinary building, where, as an ordinary rule, two machines are put in for use against the chances of breakdown, the machines have to run in multiple arc, because the wires are fed from the same feeder. Our alternating station is run in practically the same way, only instead of switching the dynamo out of the multiple arc we switch a feeder into the multiple arc on another dynamo. Our dynamos are united inside of our circuit. In the central station we simply shut down the dynamo and we transfer the feeder load. I cannot see that running the station in multiple arc is any particular advantage, or that running an isolated plant in multiple arc bears upon the question directly. It is an advantage to run a multiple arc, but in central station work the advantage is not so great as in isolated plants.

Mr. Leonard: I have one further remark to make, and it is this: Mr. Smith explained how he was going to reduce the loss of the final converters of the circuit by throwing off a part of the load when the load became too heavy. This necessarily assumes an arrangement of converters in multiple arc on the secondary which is not contemplated in my scheme, and is not in practice to-day.

Dr. Bell: At the risk of stirring up all parties in this discussion I want to make one or two suggestions with regard to this scheme, and the first of them is to suggest the question as to whether or not a 220-volt alternating circuit is a pleasant thing to have around the house. I have very grave doubts about that. I am not afraid of the direct circuit of 220 volts, but when it comes to turning loose 220 volts on a three-wire alternating system around and about the house, it seems to me that it is a good thing to avoid. I know that there are plenty of alternating current men who say that they have no fear of a current of 1,000 volts. But in all seriousness I think that 220 volts alternating current is a thing which has got to be handled rather delicately if buildings are to be customarily wired for it. I do not know that there would be any risk to life from 220 volts alternating current, but at the same time I think the public would view the matter with a little doubt. As to the question of alternating currents I think that we ought to remember that on

the other side of the water alternating currents are habitually run for the purpose of keeping the whole system loaded to its fullest capacity. We do not happen to do it here, but they do make a practice of it over there, and with great success. As to the reason for it, I think it is all summed up in the saying that it is a good thing not to put too many eggs in one basket. If you have a 100 kilowatt machine, and anything happens to it, the whole station is down right then and there until that machine is fixed. If you have three or four smaller machines, you may be able to crowd on a load and thus keep going. But I have heard grave doubts suggested by those who know Ferranti personally, as to whether he will ever complete those machines. There is such a thing as getting an alternating current so big that you cannot handle it efficiently, and I think that those units of Ferranti come very near that.

Mr. T. CARPENTER SMITH: I have brought a good deal of unpleasant newspaper comment upon myself by certain statements that I have made in public, but I have made those statements, and I am prepared to stand by them, and every experience that I have had since making them has only confirmed my belief. For the whole public I cannot speak, but for a certain small section I can speak. We did have—but have changed them all for other reasons—several buildings in which we had 220 volts of alternating current. The buildings had been originally wired for the three-wire system, but with very small wire. We had to make the change rapidly, and could not take time to increase the size of the wire. We took four 50-volt converters and coupled the primaries in multiple arc, and put secondaries in each system, and put them across the three-wire system. We found that our customers did not object half as much to the 220-volt shock to the alternating current as they did to the 220-volt direct. The shock is undoubtedly a great deal more unpleasant, and for that reason I think it is rather a good thing, for it discourages meddling with the current which the customer is only prone to indulge in. The real danger to life, I think, must not only be taken into consideration in that shock, but the far greater danger, from fire. We have no hesitation in saying, and we do not think there is any insurance man here present who will not agree with the statement, that the danger of fire from an alternating current of 220 volts is not ten but one hundred times less than from 220 volts of the direct. Another thing: our three-wire stations have developed in practice (although I doubt if any of them would admit it in public) a very easy but very reprehensible practice of burning out their grounds at night. When they discover a ground upon the system they find it easier and cheaper just to switch in three or four big machines and burn it out, finding out next morning where the ground was. That is pretty bad practice as regards the danger to life, and I think very much greater than any chance of any accident arising from a 220-volt shock. I am not contending for 220 volts of alternating current. I do not like it myself. I am only pointing to the fact that as compared one with the other, if 220 volts of direct has not been found dangerous or objectionable, the 220 volts of alternating will not be found so.

As there was no more discussion on this subject the next paper on the programme, by Mr. Burleigh, on "Uniformity in Method of Keeping Central Station Accounts," was read and was as follows:

UNIFORMITY IN METHOD OF KEEPING CENTRAL STATION ACCOUNTS.

By J. J. Burleigh.

The National Electric Light Association partially fills its mission by bringing together, twice a year, central station managers and others interested in the production of light and power, but notwithstanding the very valuable paper of Mr. A. R. Foote, read at the Niagara Falls meeting, and the papers of Messrs. Smith and DeCamp, read at the Kansas City meeting, absolutely nothing has been accomplished toward a uniform system of accounts or a classification of expenses.

All, I am sure, feel the very great necessity for a more comprehensive and uniform system of accounts—a system that will show the exact cost per unit of their output; a system that, being kept uniformly by all, will give managers an opportunity of comparison with each other.

This knowledge of cost per unit of output is particularly felt at this time, since nearly all central stations are in direct and active competition with other illuminating companies and with other means of supplying power.

At present no two keep their accounts alike, hence comparison with each other is out of the question.

The principal function of accounting is to bring out the fact that the average cost of certain items of expense per unit of output in one station exceeds the average cost per unit of the same items of expense in another station, and the accuracy of these averages depends entirely on the uniformity of accounting. Great differences in these averages would prompt an inquiry as to the cause, and if the circumstances did not warrant higher averages steps could be taken to reduce the cost of these particular items.

To make these comparisons of any value to those desiring to make use of them, a uniform classification of accounts should be adopted, and to insure accuracy the different items of expense, chargeable to the different accounts, should be specified.

The operating accounts proper embrace the current working expenses and the cost of keeping in good order the original plant.

The company with which I am connected have classified their accounts as follows:

CHARGEABLE TO	Arc lighting.	Incandescent lighting.	Power. St. cars.	Power. Stationary.	Total.
Boilers, repairs of					
Belting, repairs of					
Boiler house and stock, repairs of					
Carbons					
Clerks					
Converters, repairs of					
Dynamos, repairs of					
Dynamo attendants					
Enginemen and firemen					
Engines, repairs of					
Fuel					
General officers' salaries					
Horses, wagons and harness					
Insurance					
Interest on notes, bonds and mortgages					
Incidentals					
Instruments of all kinds					
Lamps, repairs of					
Lamp supports and fixtures					
Lamp globes					
Lamps, incandescent					
Linemen					
Labor at stations					
Labor on street cars					
Loss and damage					
Legal expenses					
Meters, repairs of					
Motors, repairs of					
Oil					
Office expenses, repairs and furniture for					
Poles and lines, maintenance and renewals of					
Right of way					
Station, repairs of					
Stationery and printing					
Superintendent and foremen					
Steam piping, repairs of					
Shafting, repairs of					
Taxes, city					
Taxes, state					
Tools, repairs and renewals					
Trimmers and inspectors					
Water					
Waste					

All expenses that are naturally or entirely charged to either arc lighting, incandescent lighting or power, are entered in their respective columns; expenses that are not entirely charged to any one service are apportioned on horse power output basis, making the division as between arc, incandescent or power, in the proportion which the horse power used for each bears to the total horse power output.

For the proper division of those accounts not chargeable entirely to any one of the principal departments, for example, the total output of the station being 1,000 h. p., the company operating 500 arc lights, 2,500 incandescent lights and 250 h. p. for power, the division of a bill for boiler repairs, engine repairs, fuel and similar divisible accounts would be one-half arc lighting, one-fourth incandescent lighting, one-fourth power. The division to be accurately determined each month.

No intelligent economy can be practiced without a thorough knowledge of the cost in the past and a comparison of the same with the present outlay. Constant comparison of accounts tends to economy. The experience of other companies is a good guide and would be found of great utility.

I would like to urge upon the convention the importance of the adoption of some uniform classification of expenses that they can recommend to central station managers for their adoption.

It does not follow that central station managers are to expose their books in detail, but so prepare their accounts that they can give the secretary of the National Association replies to such questions of cost per unit as would be proper to exhibit to the other members.

Such statistics would be of the greatest interest and value; indeed, it would be of more value than all the other papers combined.

I have a station producing arc and incandescent light and power, earning a moderate dividend for its shareholders, but I have nothing to guide me as to how my expenses per unit compare with other central stations. I would give much for such information.

CAMDEN LIGHTING AND HEATING CO.

COMPARATIVE STATEMENT OF EXPENSES.

HEADS OF ACCOUNTS.	Month of 189..	Month of 189..	Increase.	Decrease
Boilers, repairs of				
Belting, repairs of				
Boiler house and stack, repairs of				
Carbons				
Converters, repairs of				
Clerks				
Dynamo, repairs of				
Dynamo attendants				
Enginemen and firemen				
Engine, repairs of				
Fuel				
General officers' salaries				
Horses wagons and harness				
Insurance				
Interest on notes, bonds and mortgages				
Incidentals				
Instruments of all kinds				
Lamps, repairs of				
Lamp supports and fixtures				
Lamp globes				
Lamps, incandescent				
Linemen				
Loss and damage				
Labor at station				
Labor on street cars				
Legal expenses				
Meters, repairs of				
Motors, repairs of				
Oil				
Office expenses, repairs and furniture				
Poles and lines, repairs and renewals				
Right of way				
Station, repairs of and furniture for				
Stationery and printing				
Superintendent and foremen				
Steam piping				
Shafting				
Taxes, city				
Taxes, state				
Tools, repairs and renewals				
Trimmers and inspectors				
Water				
Waste				
Total expenses for month				

CAMDEN LIGHTING AND HEATING CO.

STATEMENT OF EXPENSES FOR.....189

HEADS OF ACCOUNTS.	Arc lighting.	Incandescent lighting.	Power. Street cars.	Power. Stationary.	Total.
Boilers, repairs of					
Belting, repairs of					
Boiler house and stack, repairs of					
Carbons					
Converters, repairs of					
Clerks					
Dynamo, repairs of					
Dynamo attendants					
Enginemen and firemen					
Engine, repairs of					
Fuel					
General officers' salaries					
Horses, wagons and harness					
Insurance					
Interest on notes, bonds and mortgages					
Incidentals					
Instruments of all kinds					
Lamps, repairs of					
Lamp supports and fixtures					
Lamp globes					
Lamps, incandescent					
Linemen					
Loss and damage					
Labor at station					
Labor on street cars					
Legal expenses					
Meters, repairs of					
Motors, repairs of					
Oil					
Office expenses, repairs and furniture					
Poles and lines, repairs and renewals					
Right of way					
Station, repairs of and furniture for					
Stationery and printing					
Superintendent and foremen					
Steam piping					
Shafting					
Taxes, city					
Taxes, state					
Tools, repairs and renewals					
Trimmers and inspectors					
Water					
Waste					
Total expenses for month					

Total average arc lights, ...
Total arc light hours, ...
Total cost per arc light hour, ...
Total inc. output in ampère hours, ...
Total as shown by meters .....
Total loss, ...
Total cost per 100 ampère hours, ...
Total stat'y power output in watt hours, ...
Total as shown by meters, ...
Total loss, ...
Total cost per 1,000 watt hours, ...

CAMDEN LIGHTING AND HEATING COMPANY.

GENERAL STATEMENT OF EARNINGS AND EXPENSES FOR MONTH OF.....189.....

EARNINGS. From	189..	189..	Increase.	Decrease.
Arc lighting				
Incandescent lighting				
Power—street cars				
" stationary				
Miscellaneous sources				
Total				
Net				

EXPENSES. Expenses of	189..	189..	Increase.	Decrease.
Arc lighting				
Incandescent lighting				
Power—street cars				
" stationary				
Total				
Net				

EARNINGS AND EXPENSES, SHOWING NET EARNINGS.

From all sources,	Gross earnings.	Expenses.	Net earnings.
Month of			
Same month last year			
Increase			
Decrease			
Jan. 1 to			
Same period last year			
Increase			
Decrease			

DR. BALANCE SHEET. CR.

To	By

Respectfully submitted,

.....Secretary.

Mr. Burleigh: I know of the many difficulties in bringing this matter before the attention of the convention. I know of the many difficulties that beset the way of a uniform classification of accounts. We have all fairly started on our way with our own particular plans. To change them would be embarrassing in many, perhaps in all cases, but great good would follow a uniform classification. I do not mean that we should all keep our accounts alike, but that we should agree on certain headings for our expense charges and what items are to go to those expense headings. So that when I hear my neighbor say that his arc light cost him so many cents per arc light hour I know what makes up that. I know whether he includes interest or not. Some keep a depreciation account, others do not, and so on. The forms that are appended have no particular merit over other forms. My whole thought is to get a uniform classification of expenses.

Mr. Nicholls: I have listened with a great deal of interest to this paper, and I shall consider it of more interest still when I have an opportunity of carefully and at my leisure going into the varied detail schedules that Mr. Burleigh has prepared. But as it may be of interest to the association, I will draw attention to two points which I have adopted in my practice which I find of incalculable value. To begin with, I have two private abstract books bound, with a lock and key on them, so that while they are kept in the regular vault they are not accessible. In the first book I have our charter under which we operate. I have our agreement copied in, our agreement with the city—our franchise. I have our different agreements with the different companies with which we do business. In addition to having all these put down in this book I have them indexed and cross indexed. If I have to refer to any particular clause or agreement as to powers of any kind I can by looking at this index find it at very short notice. I periodically read over these agreements, because there may be a clause in an agreement that you have pigeonholed which appears of no earthly use to you to-day, but a year from now you may find it gives you certain advantages, or that under that agreement certain rights accrue to you which you have forgotten, and which you wish immediately to take advantage of, and I think any central station manager will find a system of that kind of great advantage.

Then we have a monthly abstract of earnings and expenses. We bring everything right up to the end of the month, and I insist on having it before me not later than the 12th or 15th of the month following. In addition to having that copied out into my private abstract book, I have the cost of our power as compared with the variable expense of the station made up to what I estimate at the engine, the bus bar and at the service, allowing for the average drop. I also have the cost of our total power turned out compared with our total earnings. Then I take our light. I know whether we do our business by the meter basis, and then I figure actually what we get per horse power per hour for our earnings from incandescent lamps and from our motors, and if I am called upon to make a contract at any time I can tell for every preceding month the average. I can tell what it has cost to produce our power at the engine, at the bus bar and at the service for every month since we have been in operation, and consequently I am in a position to know exactly what we are doing. I do not know whether that is the general practice, but I find in my experience that it is of very great interest.

Mr. Francisco: There is one point here in regard to Mr. Burleigh's statement. I refer to the clause commencing on the bottom of the second and ending on the top of the third page of the pamphlet containing the paper. In regard to proper division, with an arc light circuit running commercial lights especially, how are you going to know how much power you are furnishing for your arc lights, and the same may be asked with regard to your power circuits. On a power circuit sometimes you will have a full load that may last for half an hour. Then you will have but a fourth of a load on. The point is how are you going to tell in order to fix your divisions here what proportion to divide among these different branches and how you are going to make anything accurate. I find it is impossible for me to tell what my engines are carrying at different times. The light is going on and off constantly. Most of my lights are commercial lights. Of course with the street lighting they are thrown on and off at a definite time, but with the commercial light you cannot tell anything about it. Now, how are you going to divide that so as to make anything accurate? The same with regard to Mr. Nicholls' point; as I understand him he has the card taken from his engine to get at his power. Now, if you take a card at the present time, perhaps in ten minutes from now there will be 100 h. p. taken off, and that will remain off 20 minutes, or it may come right back again.

Mr. Nicholls: I can explain that in a very few words. Although we indicate our engines frequently, we take our power card from our ampère meters. We have the readings of our ampère meters taken down every 15 minutes. Then I have a book of 400 pages, of which we use 365 pages. I have that diagram of the power output as indicated by the ampère meters plotted out on this diagram for the whole 24 hours. Last year I had it in black ink. This year I have it on the same page in red ink—the diagram of the ampère output for every quarter of an hour during the 24 hours. In regard to the other matter, I think Mr. Burleigh should properly reply to that.

Mr. Burleigh: I cannot determine accurately. I only determine approximately. But the fact that I cannot determine accurately does not debar me from getting as near to it as possible. We take our arc circuits and assume that they are full from the beginning to the end of their run. Mr. Francisco has commercial lights going out at various hours. Our commercial circuits are 12 o'clock circuits, and we assume from the start to the finish that they are full. Neither can the railroad company down there determine about its track charges, how much to charge to passenger and how much to charge to freight, but they do make a division. Nor do they stop at that division because they cannot determine the exact charge. They make it approximately. They get very near to it—near enough for their purposes—and as all systems charge alike why their comparisons are useful.

Mr. Scott: I do not want to take the time of this convention, but bookkeeping is my business; and I have a simple way of keeping the account of our stations that seems to be applicable to almost any station, because it can be subdivided. The principle of bookkeeping is like a tree branching out in every direction. Every one of those branches tends to the central trunk. The ledger is the reservoir of all accounts and the only true way of keeping books is by a ledger. If you have a ledger with 1,800 or 2,000 accounts it need be no more trouble than a ledger of two or three accounts. When you are constructing your plant, if you are careful to put all the details of the ledger each under its respective heading, if in process of time anything arises which necessitates another of those accounts you make it. The monthly report to the directors shows that the account has been increased to that extent. I had vouchers printed. For instance, the Bristol Electric Light and Power Company, to so and so, debtor. If it is construction account it goes on a construction voucher. If it is operating account it goes on an operating voucher. If it is merchandise account—for we have people who buy merchandise of all kinds, as all country stations do, it goes on a merchandise voucher. Then all you need for a journal is a simple blotter—a 25-cent book. You put that, of course, into a cash book. On the cash book I subdivide by allotting 100 pages to construction, 100 pages to merchandise and 100 pages to operating. The journal entries show: Cash, Dr. to Sundries: by Capital Account; by Merchandise; by Lamp Rentals.

Sundries, Dr. to Cash: to Construction Vouchers; to Operating Vouchers; to Merchandise Vouchers.

The posting is direct from those vouchers and those vouchers have the signature of the foreman who receipted for that bill at the bottom and also the signature of the president and secretary showing that the voucher has been passed at a regular meeting of the Board and is signed by the secretary and treasurer. For instance "The above accounts have been examined and audited by the Board at a stated meeting held Aug. 18, 1891. Received, New York, Aug. 18, 1891, of the Treasurer of the Bristol Electric Light and Power Company $125 in full for the above bill." That is the whole business. Then my ledger accounts will show, as near as I can recollect them here, capital, surplus, profit and loss, real estate, station, engine No. 1, engine No. 2, engine No. 3, engine No. 4, boilers No. 1, 2, etc., engine connections, converters, meters, poles, wire, labor and expenses on line, pins and insulators, etc., merchandise, coal, oil and waste, insurance, taxes, operating expenses (these would be small items that you would not want to keep a regular account for), wages, repairs to real estate, repairs to steam end, repairs to electrical end, maintenance of way and lamps. That constitutes a ledger account from which a balance sheet can be taken every morning and submitted to the board. If there is an increase in any of these operating accounts they want to know what it is for. Then, in addition to that, we have a lamp record which is taken from the blotter in the store room. Each customer's account shows a debit for the lamp issued with a credit for the lamp returned. Those lamps are all numbered consecutively and the numbers are entered on the record. Of course, this applies only to incandescent lighting, but it can be varied. The numbers are retained in that record. At the end of a year or six months or three months that lamp record is examined and those renewals charged in the proper account in the ledger. The Board of Directors have submitted to them monthly a balance sheet from the ledger and the board, as a committee of the whole, audit these accounts before each meeting of the stockholders and strike off for depreciation whatever they think is necessary. For instance, they look over the pole account. They know what the life of a pole is. We charge off 20 per cent. That is safe, the life of poles being pretty well known. We charge for tools from 25 to 50 per cent., according to the use they are put to, and so we go through each table on that sheet. Then the balance sheet shows a profit and loss account. The whole shows just exactly what it has cost us to run that station, to supply the number of lamps that is shown by the lamp record. For instance, last year we produced 1,919,000 ampères of current at a cost of 1,110,000 net pounds of coal. That balance sheet account can be got any month, and in that way you can get a regular system of book-keeping, not only of your profit, but your horse power and all those minor details, and I think that the simpler way that you keep those books the better. But, as I say, the ledger must be a reservoir and every stream must flow into that reservoir.

Judge Armstrong: I understand that all of our companies keep their accounts largely on the same model, or with the same end in view. Mr. Burleigh's suggestion was that we get some system so that we could all compare. As it is now Mr. Scott will give one thing one heading and we will put the same thing under another heading, or it may be we divide into two and put a part under another heading, and we do not come to a result which is exactly the same. The grand total will be, for our company just exactly the same. We will all arrive at the same conclusion for ourselves. There is no method of comparison at all, and Mr. Burleigh's plea is that we throw away our system entirely and take another heading, if you will all agree to do that, or you take ours or we will take yours—we will do anything so that we can compare the accounts together, and then if it be found necessary, as Mr. Scott suggests, to divide up one of those headings for our benefit, we can divide it up afterwards. We can subdivide it. Now in the census account they are moving on to exactly the same thing, and in a certain line we have adopted that. We have agreed as an association to that thing. If among ourselves we can agree to it, then it would be possible for me to sit down and write a confidential letter to a dozen companies and say won't you give me your item of this, that or another. That is all I need to say. They would know what I wanted, or they could write to me and I would give the same thing. That would be exactly on the same basis. We would have reduced our business then to a science, as well as the thing in which we deal. We can talk about the general principles of it, but in its commercial application we can arrive only partially at anything like a satisfactory account. Mr. Burleigh has been very much interested, I know, to satisfy me, to satisfy our directors, as to these various things, and we have been most anxious to make an intelligent comparison with the work done by other people, and so far we are unable to do it from anything we can get through the association. If it is thought desirable to do this thing, and I think the desirability of it must commend itself to every one, I should be very glad if we could have a committee to take that into consideration and as an association resolve to make some basis upon which we can all meet, upon which we can all agree.

Mr. Peck: I would suggest that this is a very important matter, and as we have a Committee on Data that that committee be instructed to appoint a sub-committee on station accounts, and that they gather all the statistics that they can before the next meeting and report as to some general system of station accounts at our next meeting.

Mr. Burleigh: Speaking to Mr. Peck's suggestion, I doubt if we could ever agree on a uniform system of keeping accounts. But we might arrive at a uniform classification of expenses—we might limit it to that.

The President: I assume that almost every man who has formulated a lot of accounts to carry on his business thinks that his accounts are as a rule kept right. Fortunately, or unfortunately, personally we in Buffalo have had access to as good an accounting system as exists in the country. Members of our company are closely allied to a corporation about which some of you know, and it is called the Standard Oil Company. They have a gas interest which is rather far-reaching. What is applicable in the main to the gas interests is applicable to the electric light interests. We have taken many of the methods that they employ in accounting, and in fact our books are practically what they have. From time to time it has seemed wise to make changes, and invariably when these changes are suggested to the accountants of the office they look very tired and say, "I have all the work I can do; this is more than I can take care of," and where one has a large station to take care of he must necessarily entrust that to his chief engineer or his chief dynamo man, or those in charge of the station, and the repairs and material there have to be accounted for by him. They have, as a rule, no ability as clerks. They are handy with a lead pencil, and they can memorize things fairly well. We have got a lot of blanks out which seem to cover the ground fairly. All our material is charged into the station, and as each dynamo has its work to perform we have whatever that dynamo costs. All the parts of that dynamo are printed up, and as we are operators of a system that sometimes burns out an armature, we have a diagram on the back of that showing each bobbin of the armature, and we indicate when that armature burns out and the causes of it. At the end of a month those are sent into the office, and the items are extended out into dollars and cents, and those are carried out into expense and maintenance of the dynamo. That is true of the boilers and engines and our line of repairs and general construction work. We have what is called a voucher ledger, and at the end of the month the bookkeeper has only one entry to make in his ledger. There is nothing entered in the ledger other than August—September—whatever date it may be—so much. But that voucher is carried out into about twenty different columns. At the end of the month you can see exactly what those items are, which you paid this money for, and refer then back to the voucher, which is, as a rule, audited before any account is taken of it, both where we are buying goods and where we made other entries, having two different colors of paper to designate our purchases and our disbursements. That simplifies bookkeeping, and with the very many accounts which we have, we find in a business of our size that we handle them very easily, and at the end of the month we know exactly how much our expenses

have been for that month, and if the board care to look into the details of it they can be readily obtained. But we have one column which shows what our expenses have been beginning with the first of January and the excess of expenditure or decrease, as the case may be, using red ink for increase and black ink for decrease; and that is carried on from month to month. That serves the purpose very well with us, and it serves the purpose very well with the gas interests of the Standard Oil Company as well as their other interests. When we make an installation with a plant or building, we have a form and everything is put down on that. That is countersigned by the superintendent and foreman of the construction gang. The prices are carried out in each individual case, and that is pinned to the contract. That disposes of that in a manner peculiar to ourselves, and we charge off a certain amount to profit and loss. When that service is discontinued we have got an investment in this customer. We can go at once to the contract, and find that his contract has cost us $25 to install that place. We have cut-out, switch, and all those appliances in that building, so much wear and other things. When that comes back to the storeroom there is an accounting made to the office. Our storerooms and stations are supplied, then a comparison is made of what is left of that stuff. The original entry is there with the contract and what comes back to the storeroom from that place is accounted for. In very great losses we inquire where has this stuff gone to, and we find that since adopting that system it has resulted in more care on the part of the various men in bringing back the wire, converters and other appliances in the places.

In the matter of cash we have a daily statement, which I assume almost everybody has. It is practically the same which Mr. Foster has in his. Many of the blanks which we use are very much like Mr. Foster's, although I think he has gone into a more elaborate accounting than we employ. But I think that with us it is almost imperative that the thing should be as simple as possible, on account of the book-keeping in the establishment. While it is very desirable to have a good accounting, if we should employ an elaborate set of blanks—and the results of course are desirable to a few—it costs a thousand or twelve hundred dollars a year more to obtain. Perhaps the end would justify the means. I have no doubt that it would. I would say here that if any member of the association would like a copy of what we have there, I should be very glad to forward blank sheets of our voucher records and other books and blanks to them. I have already sent quite a number of them out and I think Mr. Ayer and a few others have those ; but it is not anything that we can take any great credit for ourselves, for the reason that I stated.

On motion of Mr. Seely the convention then adjourned until the following day at 10 A. M.

FOURTH SESSION.

The association met at 10 A. M. and the president read an invitation from the Business Men's Association, of Norfolk, Va., to hold the next meeting of the association in that city ; also an invitation from Robert M. May, Mayor of Augusta, Ga., and from the Cotton Exchange, from the Exposition Company, and from the Commercial Club, all of Augusta, Ga., to hold the next meeting of the association in that city. On motion of Judge Armstrong the invitations were received and referred to an executive session.

The first business of the morning was the reading of the following paper by Capt. Eugene Griffin :

THREE YEARS' DEVELOPMENT OF ELECTRIC RAILWAYS.

By Eugene Griffin.

The first recorded description of the electric car is found in the fourth verse of the second chapter of Nahum : "The chariots shall rage in the streets; they shall jostle one against another in the broad ways; they shall seem like torches; they shall run like the lightnings."

Notwithstanding this early mention it was not until 1888 that the electric railway became a practical commercial success. I fix the date at 1888, as it was in that year that Bentley & Knight opened the Allegheny City road to regular traffic ; that the Sprague company equipped the Richmond road, and the Thomson-Houston company installed the Eckington & Soldiers' Home road in Washington. It was in 1888 that railway officials began to realize the possibilities of this new tractive force ; that the great West End system of Boston adopted electricity to the exclusion of cable, and that orders began to flow in upon the electric companies for street car motors to such an extent as to soon make the manufacture of such motors one of the leading branches of the electric industry.

Previous to 1888 electric motors had been used on several roads. Some of these roads were doing well and have been prosperous since; but to the public these were experiments on a comparatively small scale, and did little to inspire general confidence. The early inventors found it difficult to secure adequate financial backing; orders were few and business unprofitable. The stronger companies which took up the work in 1888 had the organizations and capital necessary to achieve success.

The pioneers who devoted their brains and frequently their purses to this work previous to 1888 are deserving of all credit. It was their misfortune, not their fault, that their ideas were not developed and worked commercially. It is difficult for one man to combine the qualities of inventor, manager, superintendent, seller, expert and financier, and yet this is what Van Depoele, Daft, Bentley and Knight and others had to attempt. The record of their efforts is an interesting one, but the chronological record of electric traction has been so frequently given that it would be a waste of your time to repeat it again.

There are, however, one or two of the early trials that are specially worthy of consideration, not only because of what was actually accomplished, but principally on account of their bearing on later developments. On July 27, 1884, an electric car was running scheduled trips over a mile of track of the East Cleveland Street Railway Company, in Cleveland, O. This was the first electric car in regular operation on a street railway track in the United States. The motor was placed between the wheels and supported from the car body, and geared to the axles by belts of spring wire cables. The current was conveyed to the car by the conductors supported on insulators in a small, wooden conduit, and connection made with the conductors by means of a plow extending through the slot to the conduit. This was the initial installation of the Bentley & Knight system. Mr. Bentley has a photograph of the car in his office in Boston.

The road was given up in 1885, and the Bentley-Knight works transferred to Providence, R. I. After various experiments the road in Allegheny City was begun in the summer of 1887. The cars were started during the winter of 1887-8, although the road was not formally opened to traffic until February, 1888. Four cars were furnished to this road which, I believe, are still running. On the lower end of the road was a mile of double track conduit which was continued by an overhead system of about five miles. The conduit was on a long grade of about 12 per cent. Over-running trolleys were used with the overhead system. The conduit was in operation for two years or more, but has now been taken up and replaced by the overhead system.

As early as 1874, while C. J. Van Depoele was engaged in Detroit, experimenting with electric motors, generators, etc., it occurred to him that trains of cars, and even ordinary street cars, could be run by electricity. This was demonstrated to the satisfaction of his associates in various ways, but no public exhibition was made until 1883. When the Chicago elevated railway was under consideration, it was proposed to demonstrate the feasibility of utilizing electricity as a motive power. A track 400 feet in length was built, with a 5 per cent. grade in the centre. One car was equipped with a 3 h. p. motor and ran for several weeks with considerable success, carrying crowds of people. This was in February, 1883. In the same year an elevated railway car was operated electrically at the Chicago Inter-State Fair. The car was suspended from the truck instead of being mounted on it; and was in operation during the entire exposition—some fifty days.

During the Toronto Annual Exhibition in 1884, an electric railway some 3,000 feet long was operated from the entrance to the grounds to the main building. This was a conduit road, and the wires carried a potential of over 1,000 volts without accident. A 30 h. p. electric locomotive was used hauling trains of cars.

The Van Depoele company subsequently equipped roads at Minneapolis, Minn.; Montgomery, Ala.; Detroit, Mich.; Windsor, Ont.; Appleton, Wis.; Port Huron, Mich.; Scranton, Pa.; Lima, O.; Binghamton, N. Y.; Ansonia, Conn.; Dayton, O.; Jamaica, N. Y.; St. Catherines, Ont., and elsewhere, many of which are still in operation.

In the fall of 1887 Frank J. Sprague contracted for the electrical equipment of the Union Passenger Railway at Richmond, Va. This was an important road in a large city, and Mr. Sprague's undertaking was the most ambitious effort in this direction up to that date. It is worthy of note that Sprague's original intention was to use motors with but one reduction, but he was forced to abandon this idea as none of the electrical companies of that date were able to produce single reduction motors. The motors used at first were too light for the work, the copper brushes scored the commutators badly and were rapidly consumed. Nevertheless, Mr. Sprague persevered despite all obstacles, and in 1888 the road was running with so much success that it was one of the object lessons which induced Henry M. Whitney and his brother directors of the West End Street Railway of Boston to adopt electricity as a motive power when they were already far advanced in the plans for cabling their system.

As nearly as can now be ascertained the following electric roads were actually in operation on Jan. 1, 1888:

Roads.		Location.	Miles.	No. of mtr. cars.
Union Pass. Ry. Co.	Daft	Baltimore, Md.	2.00	3
Windsor Elect. Ry.	Van Depoele	opp. Detroit, Mich.	1.25	2
Appleton "	"	Appleton, Wis.	5.50	5
Port Huron "	"	Port Huron, Mich.	2.75	4
Highland Park	Fisher	Detroit, Mich.	3.25	4
Scranton Suburban road	Van Depoele	Scranton, Pa.	5.00	12
Los Angeles Elect. Ry. Co.	Daft	Los Angeles, Cal.	5.00	6
Lima Street Ry. and Motor Power Co.	Van Depoele	Lima, Ohio.	4.00	8
Columbus Consolidared Street Ry.	Short	Columbus, Ohio	1.00	2
St. Catherines Str. Ry. Co.	Van Depoele	St. Catherines, Ont.	7.00	12
Seashore Electric Ry. Co.	Daft	Asbury Park, N. J.	4.00	18
San Diego Street Ry. Co.	Henry	San Diego, Cal.	3.00	9
E. Harrisburg Pass Ry. Co	Sprague	Harrisburg, Pa.	4.50	10

A totel of 13 roads, 48.25 miles of track and 95 cars.

On July 1, 1891, there were 354 roads in actual operation, with 2,893 miles of track equipped electrically, and 4,513 motor cars. Such has been the growth of three and a half years.

This development has been marvelous and unprecedented. Referring to it, General Francis A. Walker said to me, not long since, that it seemed as though at least thirty years' normal development has been crowded into three years.

It has indeed been a fruitful period, and the progress has been so rapid that the public are just beginning to appreciate the benefits which science has conferred upon them by the adaptation of the electric motor to street car propulsion.

During the past spring the legislature of the State of Massachusetts was considering a proposition which practically amounted to the imposition of new taxes upon the West End Street Railway Company, and the abrogation or virtual annullment of certain vested rights which the company might claim. In his able and vigorous defense of his corporation, President Whitney was forced to investigate and determine the true relations which exist between his company and the public, and he was surprised himself to see how closely the welfare of the city of Boston and its surrounding suburbs was identified with the welfare of its street transportation system.

He at once entered upon a "campaign of education," and his speeches in Sommerville, Roxbury, Dorchester and elsewhere (several of which have been published in pamphlet form) are masterly, impressive, straightforward and convincing presentations of the close relations which exist between the rapid transit systems and the health, wealth, morality and prosperity of our large cities.

I commend these speeches to the consideration of you all. I have not hesitated to draw from them largely myself.

I consider this growing realization of the true position which transportation companies occupy in respect to the public as one of the most important of recent developments, and it may be well to give it some consideration.

The officers and directors of a street railway company are *quasi* public officers with most important and serious duties devolving upon them. Their duty to their stockholders is to see that the company is economically and efficiently administered so as to produce a fair return upon the capital invested. Their duty toward the public is to see that the best possible transportation facilities are afforded, having in view "the greatest good of the greatest number." This broad statement of their public duty is unquestionably true, and yet the failure to appreciate this axiom is the most fertile source of adverse criticism of railway management. The critic almost invariably argues from a personal standpoint. If he would only remember that the road is run for the benefit of the masses and not for his personal individual benefit, the lives of general managers would be made less burden some.

The last census has clearly shown a strongly marked tendency of our population to gravitate toward the large cities. In every State the percentage of growth in cities is far greater than in towns and villages. Such condensation of population means an increase of the tenement house system in contradistinction to the cottage system, a crowding of people beneath each roof, an increase in vice, immorality, misery, crime and the death rate. How is it to be avoided? The laborer must live near his work, near in time and near in money. He can spare but a fraction of his time, but a fraction of his day's wages in going to and from his work. If the zone fare system exists as in Europe, the area within which he can live is limited by this consideration. Two cents per mile might restrict him to a radius of 2½ miles (5 cents). If the single fare system prevails as in this country, time is practically the only restriction. Let us assume that he can allow thirty minutes morning and evening for his car ride, paying five cents for each ride. At the rate of six miles per hour, fast for horses, he has a radius of three miles and an area of 28¼ square miles within which to select a home. At the rate of nine miles per hour, slow for electricity, he has a radius of four and a half miles and an area of 63½ square miles within which to select a home. This example suffices to illustrate the point. An increase of only three miles per hour in rapidity of transit doubles the available residence area without increasing the time or expense of the laborer in going to and from his work.

The steam road, the elevated road, the underground road and the cable, each and all afford rapid transit; but their application is restricted within very narrow limits because of their great cost, while the electric roads can be profitably extended in all directions.

The great advantage of increasing the available residence area, of encouraging the cottage system and discouraging the tenement system, will be readily conceded by all. The health and morality of a great city are universally proportional to the number of people beneath each roof. The electric railway is one of the great moral agents of the nineteenth century.

The experience of the past three years has settled many disputed questions, resolved many doubts, systematized methods and improved construction.

A variety of styles, systems and methods were used prior to 1888. We had storage batteries, conduits and overhead wires ; single trolley and double trolley wires, over-running trolleys and under-running trolleys.

Storage batteries have made little progress. They have nowhere scored a pronounced success, and have been abandoned on nearly every road. They are but little considered in the field of electric traction, except in reference to future possibilities.

The very few conduits built have disappeared and have been replaced with overhead wires. The overhead wire is now generally recognized as the only practical method of conveying electricity from the generator to the car motor.

The objections to overhead wires have been, and in many places still are, very strong; but actual experience has shown that the objections are not well founded. Wires are not an ornament to the street, and objections on this ground will always exist; but lamp-posts, signs, railway tracks, and many other similarly useful objects are not ornaments. Overhead wires will never be condemned on this ground alone. Objections on the score of unsightliness become of less and less importance each year as the methods of construction are improved and the public appreciate more fully the benefits of electric motive power.

One of the early apprehensions in reference to the use of overhead wires was the possible danger to life from the current used. On this point I think the public are now well satisfied. While there are few employés on any of the roads now in operation who have not had the full shock of 500 volts repeatedly, there is not a single instance of any of the patrons of these roads who have been killed or even seriously

injured by the 500-volt current from the overhead wire. Electric cars will run over and kill the careless pedestrian or the drunken passenger who falls from the platform in front of the wheels as will the horse car, but no passenger or pedestrian has ever been killed by the trolley wire, and statistics do not show that the electric car is in any respect any more dangerous to life than the horse car or cable car. Last year (1890) the West End street railway system of Boston carried 114,853,081 passengers and all the steam railroads of the whole state of Massachusetts only carried 98,843,712. The West End system killed 15 passengers and employés and the steam roads killed 325. Of the 15 fatal accidents on the West End system, five were attributable to electric cars and 10 to horse cars. It is only fair to say that the narrow and crooked streets of Boston and the enormous traffic of the West End system are conditions peculiarly conducive to accidents.

The fear of the electric current is one born of ignorance, and time alone can overcome it.

In the year 1889 nine human beings were killed by the arc light wires in New York City (2,500 volts), and the authorities were roused to such a pitch of frenzy that the poles were chopped down and a large part of the city left in darkness. Yet, with perhaps one exception, all of the victims were employés of the lighting companies, and suffered because of failure to observe proper and well known precautions. In the same year twelve persons were asphyxiated by gas and over thirty were killed by signs and other objects falling on their heads as they walked peacefully along the streets.

In time we are able to estimate every danger relatively, but in the beginning unknown dangers, those to which we are not accustomed, are greatly exaggerated.

Ralph W. Pope, in a very interesting paper read before the Franklin Institute last year, gives some curious illustrations of this tendency to magnify unknown dangers and arrest the progress of improvement. I quote:

"In an article entitled 'How Our Ancestors Traveled,' we find the following pertinent observations on the subject:

"Carriages met with great opposition at their first introduction, and laws were made to suppress their use. As early as the year 1294, Philip the Fair, of France, issued an ordinance for suppressing luxury, in which the wives of citizens were forbidden the use of carriages. Beckmann tells us that there is preserved in the archives of the county of Mark an edict, in which the feudal nobility and vassals are prohibited from using coaches under pain of incurring the punishment of felony. Duke John of Brunswick published an order in 1588, roundly rating his vassals for neglect of horsemanship and forbidding them to appear or travel in coaches. A few years after this the English Parliament took up the discussion of the subject; but on the 7th of November, 1601, the bill to restrain the excessive use of coaches within the realm of England was rejected. But the bitterness of antagonism to them did not cease with this legislative decision. In a pamphlet called the 'Great Concern of England Explained,' published 1673, the writer very gravely attempts to make out that the introduction of coaches was ruining the trade of the realm. Following is an example of his method of reasoning: 'Before coaches were set up travelers rode on horseback, and men had boots, spurs, saddles, bridles, saddlecloths and good riding suits, coats and cloaks, stockings and hats, whereby the wood and leather of the kingdom were consumed. Besides, most gentlemen, when they traveled on horseback, used to ride with swords, belts, pistols, holsters, portmanteaus and hat cases, for which in these coaches they have little or no occasion. For when they rode on horseback, they rode in one suit and carried another to wear when they came to their journey's end; but in coaches they ride in a silk suit, silk stockings, beaver hats, etc., and carry no other with them. This is because they escape the wet and dirt, which upon horseback they cannot avoid; whereas, in two or three journeys on horseback these clothes and hats were wont to be spoiled; which done they were forced to have new very often, and that increased the consumption of manufacture.' In another part of his pamphlet the same writer puts the following query, evidently with the notion that it was a clincher: 'Is it for a man's health or business to be laid fast in four ways; to ride all day with strangers, oftentimes sick, diseased, ancient persons, or young children crying; all whose humors he is obliged to put up with, and crippled with their boxes and bundles?' As an additional objection against the introduction of coaches, the writer urges that they would discourage the breeding and lessen the value of horses.

"The following passage occurs in a protest against the construction of railways, which is preserved in the archives of the Nuremberg Railway, at Furth, which was the first line constructed in Germany. It was drawn up by the Royal College of Bavarian Doctors:

"'Travel in carriages drawn by a locomotive ought to be forbidden in the interest of public health. The rapid movement cannot fail to produce among the passengers the mental affection known as *delirium furiotum*. Even if travelers are willing to incur this risk, the government should at least protect the public. A single glance at a locomotive passing rapidly is sufficient to cause the same cerebral derangement, consequently it is absolutely necessary to build a fence 10 feet in height on each side of the railway.'

"These were all European, however, so in order to assure you that these peculiar views were held in our country, the following protest from the good citizens of Philadelphia, in 1833, against the introduction of gas, will be of interest to you.

"'Philadelphia, Nov. 28, 1833.

"'Remonstrance Against Lighting with Gas.

"'*To the Honorable the Select and Common Councils of the City of Philadelphia*:

"'Gentlemen: The subscribers beg leave to respectfully remonstrate against the plan now in action for *lighting the city with gas*, as they consider it a most offensive, inexpedient and dangerous mode of lighting. In saying this they are fully sustained by the accounts of explosions, loss of life and destruction of property where this mode of lighting has been adopted.

"'We consider gas to be as combustible as gunpowder and nearly as fatal in its acts; as regards the immense destruction of property, we believe that the vast number of fires in New York and other cities may be in a great measure ascribed to this mode of lighting. The leakage of pipes and carelessness of stopping off the gas furnish almost daily instances of its destructive effects. And when we consider that this *powerful and destructive agent* must necessarily be left open to the care and attention of youth and domestics and careless people, we only wonder that the consequences are not more *appalling*. It is also an uncertain light, sometimes suddenly disappearing and leaving streets and houses in total darkness.

"'The waters of the Delaware and Schuylkill, now considered the most pure and salubrious in the world, as many long voyages have fully tested, must soon, we fear, experience the deterioration which has reduced the water of the Thames to the present impure state, for no reservoir will be able to contain such fetid drains from such an establishment, and very soon the rivers must be their receptacle, to the destruction of the immense shoals of shad, herring and other fish with which they abound; the same cause must produce the same effect. Salmon, smelts and other fish formerly caught in vast quantities in the Thames have nearly all disappeared. The constant digging up of the streets, the circumstances of the gas pipes, which, at the intersection of each square, must come in contact with water pipes, are difficulties and evils which we would anxiously avoid.

"'In conclusion, we earnestly solicit that the *lighting our city with oil may be continued*.

"'And your petitioners, etc.

"'Signed by 1,200 of the leading citizens of Philadelphia, whose names are attached hereto, such as Horace Binney, Hartman Kuhn, Jacob Ridgway, Paul Beck, Henry Pratt, Benjamin Chew (on whose farm the battle of Germantown was fought), John Sargeant, Charles Wharton, Richard Willing, Edward Pennington, Robert Baux, Joshua Longstreath, Matthew Newkirk, and 1,200 others.

"'N. B.—The above are only part of the names, as many of the remonstrances have not yet come in.'"

The double and single trolley systems have each had ardent advocates, but three years' experience has decided the question in favor of the single trolley and the ground return.

In July, 1888, several roads were using the over-running trolley and it was a question whether the over-running or under-running system was preferable. Three years have decided this question also, and practically all of the electric roads of to-day operate with under-running trolleys. The "fish pole" of 1888 has been supplanted by the neat steel rod of 1891, and the "broom stick train" can no longer be spoken of with disrespect as regards outward appearances.

Three years have not passed without much litigation and already we have historical cases finally determined, which tend to fix the legal boundaries of the rights of electric railways. Some of these decisions are of great importance.

The telephone companies have quite naturally been ardent advocates of the double trolley, and, to avoid suffering from the induced currents of the single trolley, they have sought to induce the courts to compel railway companies to use metallic circuits. A recent decision of the Supreme Court of the State of Ohio is a fair statement of the present legal aspect of this question:

Single Trolley System vs. *Double Trolley.*

(Supreme Court of Ohio.)

SYLLABUS.

1. The dominant purpose for which streets in a municipality are dedicated and opened is to facilitate public travel and transportation, and in that view new and improved modes of conveyance by street railways are by law authorized to be constructed, and a franchise granted to a telephone company for constructing and operating its lines along and upon such streets is subordinate to the right of the public in the streets for the purpose of travel and transportation.

2. The fact that a telephone company acquired and entered upon the exercise of a franchise to erect and maintain its telephone poles and wires upon the streets of a city prior to the operation of an electric railway thereon will not give the telephone company, in the use of the streets, a right paramount to the easement of the public to adopt and use the best and most improved mode of travel thereon; and if the operation of the street railway by electricity as the motive power tends to disturb the working of the telephone system, the remedy of the telephone company will be to readjust its methods to meet the condition created by the introduction of *electromotive* power upon the street railway.

3. Where a telephone company, under authority derived from statute, places its poles and wires in the streets of a municipality, and, in order to make a complete electric circuit for the transmission of telephonic messages, uses the earth, or what is known as the "ground circuit," for a return current of electricity; and where an electric street railway afterward constructed upon the same streets is operated with the "single trolley overhead system," so called, of which the ground circuit is a constituent part, if the use of the ground circuit in the operation of the street railway interferes with telephone communication, the telephone company, as against the street railway, will not have a vested interest and exclusive right in and to the use of the ground circuit, as a part of the telephone system.

The telephone companies have been beaten in every case, and the fact has been definitely settled that railway companies may use a single overhead trolley wire and a ground return without infringing any rights of the telephone companies.

Many interesting legal questions have arisen in reference to line construction.

Objection was made by the summer residents of Newport to the construction of an overhead electric railway, and eminent counsel was employed to place every possible legal obstacle in the way. The case was carried to the Supreme Court of the State of Rhode Island for determination of some of the novel points involved, and one of these points was:

Are poles and wires an additional servitude upon the streets?

The court held:

"The fourth ground alleged is that, if the act of incorporation authorizes the use of electricity for the operation of said street railway, and the erection of the poles as ancillary thereto, it is unconstitutional and void, because it authorizes the imposition of additional servitude upon the streets without providing for any additional compensation to the owners of the fee of said streets. We think it is settled by the greater weight of decision that a railroad constructed in a street or highway, and operated by steam in the usual manner imposes a new servitude, and entitles the owner of the fee to an additional compensation; but that a street railway operated by horse power, as such street railways are ordinarily operated, does not impose any new servitude, and does not entitle the owner of the fee to any additional compensation.

"The distinction is not often stated as a distinction between steam and horse railroads; but the distinction properly rests, not on any difference in motive power, but on the different effects produced by them respectively on the highways or streets which they occupy. A steam railway is held to impose a new servitude, not because it is operated by steam, but because it is so operated as to be incompatible with the use of the street in the other usual modes, or, in other words, so as practically to exclude the usual modes of use.

"A steam railroad on a street, so operated as to be consistent with the use of the street in the usual modes, has been held not to impose a new servitude.

"It is not the motor but the kind of occupation, whether practically exclusive or not, which is the criterion.

"The only considerable privilege which the horse car has over other vehicles, is that, being confined to its tracks, it cannot turn aside for other vehicles, while they are forced to turn aside for it; but this is an incidental matter, insufficent to make a horse railroad a new servitude.

"The street railway here complained of is operated neither by steam or horse power, but by electricity. It does not appear, however, that it occupies the streets or highways any more exclusively than if it were operated by horse power.

"Reference has been made to cases which hold that telegraph or telephone poles and wires erected on streets or highways constitute an additional servitude, entitling the owners of the fee to additional compensation, and from these cases it is argued that the railway here complained of is an additional servitude, by reason of the poles and wires which communicate its motive power. There are cases which hold as stated, and there are cases which hold otherwise, but, assuming that telegraph and telephone poles and wires do create a new servitude, we do not think it follows that the poles and wires erected and used for the service of said street railway likewise create a new servitude. Telegraph and telephone poles and wires are not used to facilitate the use of the streets where they are erected for travel and transportation, or, if so, very indirectly so; whereas the poles and wires here in question are directly ancillary to the uses of the streets as such, in that they communicate the power by which the street cars are propelled."

In the purely technical field all obstacles have been overcome. Like Perry, "We have met the enemy and they are ours." The severe strain imposed by railway work on the generating plant has necessitated the development of new types of engines and the fluctuations of the dynamos have been prevented by compound winding and series coils. Self-regulating dynamos are now considered necessary in any well planned power plant.

I attended the exposition at Bremen, in North Germany, last summer, and had the pleasure of riding on an electric railway operated by two 80-h. p. Thomson-Houston dynamos. One dynamo was driven by a 70-h. p. Armington & Sims engine, and one by a 125-h. p. German engine. So closely did the small American engine regulate that no variation in potential could be observed under the most violent and sudden variations in load. Notwithstanding its greater power, the German engine was slow to respond and the variations in speed were marked. I was subsequently informed that a medal was awarded to the American engine, although it had not been entered as an exhibit.

This is indicative of the enterprising way in which the inventors and manufacturers of the United States have met the new conditions imposed by the adoption of electricity as a motive power.

The difficulties Mr. Sprague encountered in Richmond in using copper brushes have now been avoided by the introduction of the carbon brush, for which we are indebted to Mr. C. J. Van Depoele.

As early as 1883-4 Van Depoele used carbon brushes with his motors. When the Van Depoele Electric Manufacturing Company was purchased by the Thomson-Houston company in 1888, Van Depoele went to the Lynn factory of the latter company. Many did not then consider the carbon brush as practicable, and it was some time before Mr. Van Depoele had an opportunity to demonstrate its possibilities. When the time did come its great value was so apparent that it was at once adopted for motor work and subsequently has been used exclusively with generators.

Since the general adoption of the present method of mounting the motors directly on the axles, double reduction motors have been used. The supposed necessity of high speed of revolution in the armature made this obligatory. In 1890 it was found practicable to make motors in which the armature revolved at a slower rate, and a single gear sufficed for the now greatly reduced reduction. From 10 and 12 to 1 with the old motor we come to 4½ to 1 with the new motors. The gears are enclosed in boxes and run in oil, so that the noise has been reduced to a minimum, the offensive noise of the gears being practically eliminated. We have also gearless motors with no reduction and no gears.

Generator construction has kept pace with the improvements.

As larger stations have been built generators have increased in size, and electrical companies are now producing

500 h. p. dynamos as readily as the steam engine builders respond to similar demands

We have learned what it costs to operate electric railways and the result is gratifying. In 1888 it was prophesied that while electric roads might make good showings so long as the apparatus was new and curiosity riding lasted, in a short time the machinery would begin to wear out and the roads would be swamped by the great repair bills. In reality we find the almost universal testimony is that the longer the road runs, the less is the cost of repairs. This is, of course, not due to the fact that the apparatus improves in quality with age, but the explanation is to be found in the very simple fact that as small defects are eliminated and the employés become more experienced and the organization is perfected, the apparatus is better cared for and injuries are prevented.

A very conspicuous example of this is the West End Street Railway, which has been under my own immediate observation.

In the contract between the Thomson-Houston Electric Company and the railway company it was provided that we should keep the overhead line and electrical apparatus on the cars in repair at a given price per car mile. There were many reasons which influenced us to enter such a contract, but the chief reason was that this was the uncertain element in the operation of an electrical railway, and unless this uncertainty could be eliminated the West End would not make any contract. The cost of these repairs has steadily decreased, and on Oct. 1 the West End company avail themselves of their option and relieved us of this part of our contract, knowing there is now no uncertainty, and that they can do the work themselves for less money than they pay us.

Some months since President Whitney gave to the public the detailed figures showing the receipts and operating expenses of the West End road. These are of very great interest to all, and I give them in full for the purpose of drawing some conclusions from them:

THE ELECTRIC SYSTEM.

	April.	May	June.	July.
Gross receipts	$134,321	$144,638	$153,988	$144,552
General expenses	8,193	7,796	7,465	6,955
Track and car expenses	47,447	45,443	39,629	43,891
Motive power	30 194	30,924	26,359	26,398
Total operating expenses	85,834	84,163	73,459	77,249
Net earnings	48,487	60,475	80,529	67,303
Miles run	394,459	376,321	369,567	377,191
Ratio of mileage	26.68	25.58	25.15	25.19
Per cent. operating expenses	63.6	58.18	47.70	53.44
Earnings per mile run	34.05	38.43	42.71	38.32
Expenses per mile run:				
Motive power	07.65	08.22	07.31	07.00
Car repairs	01.39	01.33	01.18	01.17
Damages	00.75	00.89	00.16	00.12
Conductors and drivers	07.33	07.36	07.25	06.92
Other expenses	04.63	04.56	04.47	05.37
Total expenses per mile run	21.75	22.36	20.37	20.48
Net earned per mile run	12.30	16.07	22.34	17.84

HORSE CAR SYSTEM.

Gross receipts	$344,396	$374,605	$395,555	$409,878
General expenses	22.514	22,682	22,217	20,657
Track and car expenses	136,693	127,902	125,393	135,954
Motive power	117,740	118 972	116,210	116,271
Total operating expenses	276,947	269,556	263,825	272,888
Net earnings	67,449	105,049	131,729	136,990
Miles run	1,083,887	1,094,683	1,073.718	1,120,377
Ratio mileage	73.32	74.42	74.85	74.81
Per cent. operating expenses	80 62	71.95	66.70	66.58
Earnings per mile run	31.77	34.22	36.85	36.58
Expenses per mile run:				
Motive power	10.86	10.86	10.83	10.38
Car repairs	00.93	00.60	00.61	00.61
Damages	00.78	00.37	00.15	00.06
Conductors and drivers	08.24	08.24	08.25	08.23
Other expenses	04.70	04.55	01.24	05.07
Total expenses per mile run	25.55	24.62	24.58	24.35
Net earned per mile run	06.22	09.60	12.27	12.23

THE ENTIRE SYSTEM.

Gross earnings	$478,717	$519,244	$549,543	$554,431
General expenses	30,707	30,478	29,683	27,431
Track and car expenses	184,141	173.344	165,027	179,613
Motive power	147,933	149.896	142,570	142,853
Total operating expenses	362,781	253.720	337,284	350,137
Net earnings	115,935	165,524	212,250	204,294
Miles run	1,478,346	1,471,004	1,433,785	1.497,568
Ratio of mileage	100	100	100	100
Per cent operating expenses	76.82	68.12	61.37	63.15
Earnings per mile run	32.39	35.29	38.33	37.02
Expenses per mile run:				
Motive power	10.01	10.19	09.94	09.53
Car repairs	01.05	00.79	00 76	00 75
Damages	00.77	00.50	00 15	00.07
Conductors and drivers	08.03	08.01	08.00	07.91
Other expenses	04.68	04.55	04.67	05 12
Total expenses per mile run	25.54	24.04	23.52	23.38
Net earned per mile run	07.85	11.25	14.81	13.64

Taking the June figures, it will be noticed that the net earnings per electric car mile exceed the net earnings per horse car mile by 10.07 cents, while the operating expenses of the horse car lines exceed those of the electric car lines by 4.21 cents per car mile. The difference is 5.86 cents per car mile, which is the gain to the company due solely to the public satisfaction with the electric service. Mr. Arthur Jones, of the T. H. International Company, first produced this figure which he calls the "satisfaction figure."

The net earnings per electric car mile exceeded the net earnings per horse car mile by the following amounts:

In April	6.08	cents	per car	mile.
" May	6.47	"	"	"
" June	10.07	"	"	"
Mean	7.54	"	"	"

The net earnings of the horse cars for the three months averaged 9.36 cents per car mile, hence the electric cars showed a gain of 80 per cent. in the net earnings per car mile over the horse cars.

For the three months, we have the following figures for the electric cars:

Total receipts	$432,947
" expenses	243,456
Percentage of expenses to receipts	56 p. c.

In St. Paul and Minneapolis, with a combined population of 350,000, there is to-day not one single horse car. Minneapolis has 120 miles of electric railways, all equipped with the overhead system, and St. Paul has 75 miles of electric railways and 15 miles of cable. Most of the cable mileage is to be abandoned and supplanted by electricity. The last car horse disappeared from the streets of Minneapolis in June of this year. The July report of the Minneapolis system shows:

Gross earnings	$107,571
" expenses	52,585
Net earnings	54,985
Percentage of expenses to receipts	49 p. c.

Cleveland, Buffalo, Rochester, Toledo, Omaha, Cincinnati and many other large cities are now operating their street cars almost exclusively with electric motors, and the universal testimony is favorable to the increased facilities afforded the public and the increased profit to the stockholders.

Not the least important of the developments of the last three years has been the financial development. The fine showings as to earnings, the gradual decrease in operating expenses, where increases were expected, the oft demonstrated ability to run electric cars in all kinds of weather, in ice, snow, sleet, hail or rain, has greatly improved the standing of electrical securities. An electric road is no longer an experiment, it is a paying investment and there are not a few instances where the introduction of electricity has been the salvation of a horse road that otherwise would have soon been in the hands of a receiver. The rapidly increasing demand for electrical securities is an evidence of a healthy growth of public sentiment in this direction. To equip electrically means the expenditure of money which must come from an increase of the bonds or stocks issued. The ability of the public to rapidly absorb these new bonds or stocks must be the ultimate limit of the ability of the railway companies to move in this direction.

In August the West End Street Railway Company put out four millions of common stock for additional electrical equipment under a plan of subscription which provided for two deferred payments. When the subscription books were closed on the 5th of August, 33,000 shares had been paid in and only a paltry 245 shares had taken advantage of the option for deferred payments. I know of no more striking object lesson than this, except perhaps that the rapid rise of the West End common stock from 63 to 77, which immediately followed.

Electric securities have heretofore been offered at tempting figures, but the day for this is passing. The public are realizing that a good street railway security is better than a western railroad bond or stock, and the electric roads are better than the horse roads. Electric railways will pay where no one would dream of building a horse road, and when the public taste is whetted for electrical securities, we shall see a marvelous increase in the number of roads and the equipment of existing roads that will mean transportation facilities for thousands who are now unprovided, and many years' work for our electrical factories.

Mr. W. H. HAMMER: This is an admirable paper, and contains a number of chronological events which deserved to go on record, but I think that some have been omitted. To say nothing of the experiments of Dr. Siemens, whose railroad is still running in Berlin, and which dates away beyond any that Captain Griffin has referred to, I might refer to the experiments made in 1881 in Paris at the time of the Electrical Exposition. I believe the date given as the earliest in this paper was 1883. I have a very vivid recollection of an electric railroad which was in operation in 1880 and 1881, a mile and a half in length, at Menlo Park, N. J., and which attained a speed of no less than 40 miles per hour, and within a very short time after that was extended to three and a half miles in length. It was such an elaborate experiment at that time, and of such great commercial value, that I think the fact should be put on record in connection with a paper of the importance that this is.

Mr. GRIFFIN: I would like to say with reference to early experiments which I have referred to, that I did not intend that the list should be taken as complete. Perhaps I did not express it explicitly, but I intended to confine it simply to the United States. The car I refer to, on the Cleveland road—I intended to make that explicit—was the first car I know of that was in operation upon any existing street railway on the streets of a city. There were lots of experimental roads which were built in addition to those that I have mentioned, that were built for the purpose of demonstrating the feasibility and the possibility of operating street railways by electricity; but I think that that car in Cleveland was the first car that was put into regular operation upon an existing street railway upon the streets of a city, and put in schedule operation. That may be a small distinction, but such as it is, is one which Mr. Bentley and Mr. Knight have always delighted to make a great deal of.

Judge ARMSTRONG: There is one thing with which I am not yet able to agree in Captain Griffin's paper—possibly later experience may lead me to agree with his statement that it will pay to put down an electric road where a horse road would not pay. So far as my observation is concerned I cannot bear out that statement, because you can surely operate a horse railroad at less expense by running fewer cars than you can possibly operate an electric road where you have to have your steam plant and your power for producing electricity all the time ready. If you are operating on a fifteen minute or half hour schedule on street cars you do not have to do that thing to the same extent. In that respect I cannot go so far as he does in his paper. But under given conditions, where the travel can reasonably be kept at a fair schedule, that may be and perhaps is true. Our experience is that it pays us only because we carry so many more people than we did when we were operating with horses.

Dr. BELL: I had occasion last year to look into this very question with a good deal of care, and in answer to my inquiries I received replies from considerably over one hundred roads, with reference to the effect of a change of motive power on the traffic and on the actual operating expenses. The result of the experiences detailed in these replies (and they were from representatives of all the well known systems) was singularly uniform, in the statement that there had been a great increase in traffic, varying from 20 per cent. to 200 per cent., following the change from horses to electricity, whereas the actual expenses (although formerly greater with electricity than with horses) were much less in proportion to the traffic with electricity than with horses; and that furthermore very frequently a real decrease in the running expenses was observed. I think that there are certain classes of roads which are operated every day by electricity that never could be profitably operated by horses—and that is roads on grades which are far too severe for successful regular operation with horses, and which at the same time run through regions too sparsely settled to permit of surmounting grades by cables. There is a very considerable field of that kind which cannot be operated except by electricity. We are now operating in many places ten to twelve per cent. grades, and operating under circumstances where it would be almost impossible to handle the cars by any amount of horse power that you could get on the street. It is in these special cases that the advantages are most manifest, although I think to-day experience shows that in a system of anything like decent size the actual running expenses per car mile are quite a little less with electricity than with horses. Of course on the great West End system that is very marked indeed. Of course that location is specially favorable. But the balance is I think in at least one-half the cases that I have been able to get information about, in favor of electricity in the line of expense, the total expenses per car mile, quite aside from the question of increased travel.

The PRESIDENT: If there is no further discussion on the paper just read, we will proceed with the programme. Before taking up the next thing in regular order I will read the following telegram with reference to the census statistics which are being gathered with reference to the applications of the science which we represent here:

"Mr. ALLAN R. FOOTE: All investigations in charge of expert special agents have been postponed until after the meeting of Congress. All agents have been dropped, including yourself. Letter by mail."

That is looking forward to dropping the idea of gathering together a lot of valuable statistics, right at the time when we are in the middle of it. Since that telegram was received the letter has also arrived, and I think has been handed to Dr. Mason, who will give us further information in relation to it, and will give us some suggestions.

Dr. MASON: I was not thinking of being called upon at this moment to bring this matter to the attention of the convention. It is a very important matter. You will remember a year ago in our meetings resolutions were introduced relative to a committee on legislation and a motion was then made, and secured the assent of this body, urging Congress to make an appropriation in support of the movement to take a thorough census of the electrical industry. A bill which had been introduced in Congress having this object in view was urged, but at the last moment, in the pressure of business, the matter was passed over, and no appropriation has ever been made for taking the census of the electrical industries. Some $15,000, which has been already expended, have been taken from wherever he could get the money, by General Porter—all the time hoping that they could get on in that way until an appropriation could be secured by Congress. But in the confusion with regard to census matters General Porter has found himself obliged to take the action stated in this telegram, and followed up by the letter, which perhaps it is not necessary that I should read to you further than to say that in view of the facts in the case he states that it does not seem practicable for him to continue furnishing the funds as he has been doing without a special appropriation. In this letter he looks to the taking up of the work again on the part of Mr. Foote, when proper appropriations shall have been secured. It seems to me of the utmost importance that at the present meeting this association should take definite action looking to the securing of the appropriation which was asked for a year ago, and which should have been granted at the session of Congress then being held. Personally, I feel that Congress has been guilty of doing an absurd piece of business. Look at the statistics which have been brought us here in the last hour relative to the application of electricity as motive power in matters of traction. Look at what has been done in the past two years—and no statistics being gathered, no record being made, in this census of the work of the last ten years particularly, all along the various branches of applied electricity. It is now proposed that this shall be dropped, that there shall go on the record with the census of 1890 no mention of electricity. The thing is absolutely absurd. It seems to me that if properly presented to Congress at its next meeting prompt action may be had. But in the meantime what will be done? In the meantime $15,000 has been already expended, and yet the work falls to the ground unless it is carried directly forward now. I doubt whether it can be laid down and taken up again. It should go on now, and some provision should be made by the Secretary of the Interior—if the Commissioner of Census cannot attend to it himself, and he has no means at his disposal—which will enable this work to go right on from to-day. There is no propriety in having any hiatus. Feeling as I do upon this point, and feeling that we would stand before the world in a most unenviable light if this matter were dropped, I beg to offer the following:

Whereas, The Hon. Robert P. Porter, Superintendent of the Eleventh Census, has authorized the collection of the statistics of the electrical industries, and has appointed Mr. Allen R. Foote special expert agent for that purpose; and

Whereas, Mr. Foote has prepared schedules for the collection of such statistics covering nearly every known practical use of electrical energy; and

Whereas, These schedules provide for information of great public value that is imperatively demanded for the intelligent discussion and settlement of questions of grave public importance; and

Whereas, This association is advised that the work undertaken is in danger of being delayed if not altogether abandoned by reason of insufficient appropriation, thus utterly wasting the $12,000 or $15,000 already expended, and, what is of far more serious moment, depriving the people of the benefits derivable from a report that there is reason to believe would be a thorough and reliable authority on the subject of which it treats.

Therefore be it *Resolved*, 1. That this association respectfully requests the Hon. Robert P. Porter, Superintendent of the Census, or, if he is not sufficiently empowered, the Hon. John W. Noble, Secretary of the Interior, to provide for the carrying to the earliest possible completion of the work so well begun.

2. That immediately upon the convening of the 52d Congress the Executive Committee of this association be directed to secure the reintroduction of Senate Bill No. 4,329 of the 51st Congress, appropriating $50,000 for the special work under Mr. Foote's direction, and to use all proper care to secure its passage at the earliest possible date.

3. That this association hereby expresses its approval and high appreciation of the work Mr. Foote has done in his official capacity as special agent of the Eleventh Census for the collection of the statistics of the electrical industries and its belief that the reports he may prepare, if enabled fully to carry out his plans therefor, as shown by the schedules submitted by him for examination, will have a value equal to that of the most valuable reports ever issued by the United States government.

4. That the president and secretary of this association be directed to at once forward a certified copy of these preambles and resolutions to the Hon. John W. Noble, Secretary of the Interior; to the Hon. Robert P. Porter, Superintendent of the Census, and Allen R. Foote, special agent for the Eleventh Census, at Washington, D. C.

I desire to say in addition that I hold in my hand the various schedules which Mr. Foote has prepared in his foundation work for the gathering of information needed with regard to matters connected with electricity, and I have examined them with a great deal of care. I do not consider myself competent to pass judgment upon them, but I will say this, as one who has something to do with statistics, that it is the most complete of any that I have ever seen. I had something to do with the census of 1880. I would say that I have examined every part of it with the greatest care, and I know of no department of the census of 1880 that in its foundation work will compare with Mr. Foote's work as represented by the schedules in this book. I will go further and say of my own personal knowledge that the ablest men and ablest judges in our country on this subject, such men for instance as those who are at the head of our great telephonic interests and telegraphic interests, have the same opinion that I have expressed, and look forward with profound interest to the completion of this work. We are not the only ones interested, but all the industries into which electricity is entering as a factor are interested in this question. I trust this matter will not end with this association, but at the convention of the Street Railway Association similar resolutions may be passed, and that action may be taken by all other associations who are interested in kindred matters. I now offer the resolution which I have read.

Judge ARMSTRONG: I gladly second those resolutions, but I think that we ought to go further than that. I particularly appreciate what Dr. Mason has referred to, as to our stopping the work that has now been begun. A delay of six months is a most serious thing for us. Why? Because we are trying to gain information which will enable us to make great strides in advance in the next six months. That is the reason we have been having conventions twice a year. I apprehend that the reason this work is permitted to lag is largely because it is not understood. I feel that the matter is of sufficient importance to make it advisable for us to have a committee headed by such a man as Dr. Mason to go to Washington. Our resolutions may go to Washington, but do you know, in the pressure of business, what is done with resolutions that are received there? What did you formerly do with them? The importance of this matter is not understood. It is not a toy that we are playing with, but how many there are who regard the whole electrical industry as simply a toy! They do not understand it. But those who come in contact with it and who know what a business it has become, can appreciate it. As Dr. Mason has said, since the last census was made, in 1880, a new thing has come into commercial life—absolutely a new thing, but of wonderful importance. There are very few, if any, more important industries in this country than that which is connected with electricity. The interest which we represent comprises only one department of the science, if I may so term it. Let us send from this body to Washington a committee, and if we have done nothing else at this convention, if that committee succeeds in having the work continued now (and that it can be continued if the powers favor it being continued until the meeting of Congress we all know), if we accomplish nothing else in this convention but that, it will well have repaid us for coming here. I trust that Dr. Mason will add to his resolutions that a committee of three or of five members be appointed by this body to present the resolutions, and that they go to Washington and at once present them to the Superintendent of the Census, to the Secretary of the Interior, and, if it be necessary, to the President himself, in order that direction may be given for the continuance of this work. There is enough of interest in the work for us, there is enough involved in it for us as an association, to assume all the expense, and to take all the time necessary to be expended, and to make all efforts that may be required to accomplish this work, and prevent its being dropped for a month or even for a week.

The resolutions offered by Dr. Mason were unanimously adopted.

Dr. Mason then offered the following motion, which was seconded by Mr. Francisco, and was unanimously adopted:

That a committee of five members of the National Electric Light Association be appointed, who shall carry to Washington the preamble and resolutions just adopted, present the same to the Superintendent of Census, the Secretary of the Interior, and, if desirable, to the President of the United States, and urge the necessity of the continuation, without a day's delay, of the work of Special Agent Foote.

Resolved, That the association request the co-operation of other electrical associations and societies, also all associations or societies directly or indirectly interested in the subject, in measures to secure the carrying to completion of the census work commenced by Special Agent Allen R. Foote, for the collection of statistics of the electric l industries.

The PRESIDENT: On Tuesday the Committee on Safe Wiring made its report, which was received and ordered printed, and the matter was to be taken up at the earliest possible moment after the printed copies were received for distribution. The copies are here, and the matter now properly comes up for discussion.

Dr. MASON: In order to facilitate business here I want to call attention to the last words in the recommendation attached to the report of the Committee on Safe Wiring. I call your attention to the following resolution which was offered by the committee:

"That a committee of five be appointed by the president, to be a permanent Committee on Safe Methods of Construction and Operation—any vacancies that may occur on the committee from time to time to be filled by the president."

Dr. Mason then moved the adoption of this resolution, and after some animated discussion by Judge Armstrong, Dr. Mason, M. J. Francisco and others, the motion was carried.

Judge ARMSTRONG: I move that we resolve ourselves into a committee of the whole upon this matter, so as to dispose of it speedily, and without taking time to make a record of what is done except to report as a committee of the whole, and then we can dispose of the whole matter.

Mr. Mason seconded the motion, which was agreed to, and the convention resolved itself into a committee of the whole for the consideration of the report of the committee. After careful consideration of the rules in detail they were adopted in the following form:

CLASS A.—CENTRAL STATIONS.

FOR LIGHT OR POWER.

These Rules also apply to Dynamo-Rooms in Isolated Plants, connected with or detached from buildings used for other purposes. Also to all varieties of apparatus, of both high and low potential.

GENERATORS OR MOTORS—Must be:

1. Located in a dry place.
2. Insulated on floors or base frames, which must be kept filled to prevent absorption of moisture, and also kept clean and dry.
3. Not exposed to flying or combustible materials.
4. Each covered with a waterproof cover when not operating.

In no case must a generator be placed in a room where any hazardous process is carried on, such as the working-room of a cotton, jute, flax, woolen or flour mill.

CARE AND ATTENDANCE.—A competent man must be kept on duty in the room where generators are operating.

Oily waste must be kept in metal cans and removed daily.

CONDUCTORS.—From generators, switchboards, rheostats or other instruments, and thence to outside lines, conductors must be:

1. In plain sight.
2. Wholly on non-combustible insulators, such as glass or porcelain.
3. Separated from contact with floors, partitions or walls through which they may pass by non-combustible insulating tubes.
4. Kept rigidly so far apart that they cannot come in contact.
5. Covered with non-inflammable insulating material sufficient to prevent accidental contact.
6. Ample in carrying capacity to prevent heating. (See Capacity of Wires Table.)
7. Connected by splices or joints equal in carrying capacity to the conductors themselves, soldered if necessary to make them efficient and permanent.
8. When under floors or in distributing towers, placed in spaces ample for inspection and ventilation, and provided with special insulating covering.

SWITCHBOARDS—Must be:

1. So placed as to make it impossible to communicate fire to surrounding combustible material; accessible from all sides when the connections are on the back; or may be placed against a brick or stone wall when the connections are entirely on the face.
2. Kept free from moisture.
3. Made of non-combustible material, or of hard wood, filled to prevent absorption of moisture.
4. Equipped with bars and wires in accordance with Rules 1, 2, 4, 5, 6 and 7 for placing inferior conductors.

RESISTANCE BOXES AND EQUALIZERS—Must be:

1. Equipped with metal or non-combustible frames.
2. Treated as sources of heat.
3. Placed on the switch or a distance of a foot from combustible material, or separated therefrom by asbestos or cement.

LIGHTNING ARRESTERS—Must be:

1. Attached to each side of every overhead circuit connected with the station.
2. In plain sight.
3. On the switchboard or in an equally accessible place, away from combustible material.
4. Connected with at least two earths by separate wires of large size.
5. So constructed as not to maintain an arc after the discharge has passed.

TESTING.—All series and alternating circuits must be tested every two hours while in operation to discover any leakage to earth, abnormal in view of the potential and method of operation.

All multiple arc low potential systems (300 volts or less) must be provided with an indicating or detecting device, readily attachable, to afford easy means of testing where the station operates perpetually.

Data obtained from all tests must be preserved for examination by insurance inspectors.

CLASS B.—ARC (SERIES) SYSTEMS.

OVERHEAD CONDUCTORS.—All outside overhead conductors (including services) must be:

1. Covered with some insulating material not easily abraded.
2. Firmly secured to properly insulated and substantially built supports, all the wires having an insulation equal to that of the conductors they confine.
3. So placed that moisture cannot form a cross connection between them, not less than a foot apart and not in contact with any substance other than proper insulating supports.
4. At least seven feet above the highest point of flat roofs and at least one foot above the ridge of pitched roofs, over which they pass or to which they are attached.
5. Protected whenever necessary, in view of possible accidents to conductors or supports, from possibility of contact with other conducting wires or substances to which current may leak, by *dead insulated guard irons or wires*. Special precautions of this kind must be taken where sharp angles occur, or where any wires might possibly come in contact with electric light or power wires.
6. Provided with petticoat insulators of glass or porcelain. Porcelain knobs and rubber hooks are prohibited.
7. So spliced or joined as to be both mechanically and electrically secure without solder. They must then be soldered to insure preservation and covered with an insulation equal to that on the conductors.

The following formula for soldering fluid is approved:

Saturated solution of zinc	5 parts.
Alcohol	4 parts.
Glycerine	1 part.

Conductors should not be run over or attached to buildings other than those in which light or power is being, or is to be, used, but on separate poles or structures always easily inspected.

SERVICE BLOCKS must be covered over their entire surface with at least two coats of waterproof paint and so maintained.

Telegraph, telephone and similar wires must not be placed on the same arm with electric or power wires and *should not* be placed on the same structure or pole.

INTERIOR CONDUCTORS.

ALL INTERIOR CONDUCTORS—Must be:

1. Where they enter buildings from outside terminal insulators to and through the walls covered with waterproof insulation, and must have drip loops outside, preferably slanting upward toward the inside and bushed with waterproof and non-combustible insulating tube.
2. Arranged to enter and leave the building through a double contact service switch, which will effectually close the main circuit and disconnect the interior wires when it is turned "off." The switch must be so constructed that it shall be automatic in its action, not stopping between points when started, and prevent an arc between the points under all circumstances; it must indicate on inspection whether the current be "on" or "off," and be mounted on a non-combustible base in a position where it can be kept free from moisture, and easy of access to police or firemen.
3. Always in plain sight, never covered, except in special cases, where an armored tube may be necessary.
4. Covered in all cases with a waterproof non-combustible material that will adhere to the wire, not fray by friction, and bear a temperature of 150 degrees F. without softening.
5. In dry places, kept rigidly apart at least ten inches, except when covered (in addition to insulation)—by a waterproof, non-conducting and non-inflammable tubing which must be strong enough to protect the insulating covering from injury. Conductors thus placed may be run not less than three inches apart, and be fastened with staples, under which are placed mechanically rigid insulating strips or saddles of greater width than the metal of the staple, by which possibility of injury to the tube may be prevented.
6. In damp places, attached to glass or porcelain insulators, and separated ten inches or more.
7. When passing through walls, floors, timbers or partitions, treated as in central stations under like conditions.

LAMPS AND OTHER DEVICES.

ARC LAMPS—Must be in every case:

1. Carefully isolated from inflammable material.
2. Provided at all times with a glass globe surrounding the arc, securely fastened upon a closed base. No broken or cracked globes may be used.
3. Provided with a hand switch, also an automatic switch, that will shunt the current around the carbons should they fail to feed properly.
4. Provided with reliable stops to prevent carbons from falling out in case the clamps become loose.
5. Carefully insulated from the circuit in all their exposed parts.
6. Where inflammable material is near or under the lamps, provided with a wire netting around the globe and a spark-arrester above, to prevent escape of sparks, melted copper or carbon.

Incandescent lamps in series circuits, having a maximum potential of 350 volts or over, must be governed by the same rules as for arc lights, and each series lamp provided with a hand switch and automatic cut-out switch; when lights are in multiple series, such switches and cut-outs must not control less than a single group of lights. Electromagnetic devices for switches are not approved.

Under no circumstances will incandescent lamps on series circuits be allowed to be attached to gas fixtures.

CLASS C.—INCANDESCENT (LOW PRESSURE) SYSTEMS.

300 volts or less.

OVERHEAD CONDUCTORS.

OUTSIDE OVERHEAD CONDUCTORS—Must be:

1. Erected in accordance with general rules for arc (Series) circuit conductors.
2. Separated not less than six inches, where they enter buildings as service conductors, and be provided with a double pole fusible cut-out, as near as possible to the point of entrance to the building, and outside the walls when practicable.

UNDERGROUND CONDUCTORS.

UNDERGROUND CONDUCTORS—Must be:

1. Provided with suitable protecting devices at the ends of tube or conduit services inside the walls of buildings, as a guard against moisture and injury.
2. Terminated at a properly placed double pole house cut-out.
3. Of specially insulated conductors after leaving the tube or conduit, and separated by at least 10 inches, until the double pole cut-out is reached.

INSIDE WIRING.

Wire should be so placed that in the event of the failure or deterioration of their insulating covering the conductors will still remain insulated.

At the entrance of every building there shall be a double pole switch placed in the service conductors, whereby the current may be entirely cut off.

CONDUCTORS—Must not be :

1. Of sizes smaller than No. 16 B. & S., No. 18 B. W. G., or No. 3 E. S. G.
2. Lead or paraffine covered.
3. Covered with soft rubber tube.
4. Laid in moldings of any kind in damp places.
5. Laid in moldings with open grooves against the wall or ceiling.
6. Laid in moldings where less than half an inch of solid insulation is between parallel wire, and between wires and walls or ceilings.

CLEATWORK is not desirable, and cleats must *not* be used unless—

1. In a very dry place.
2. In a place perfectly open for inspection at any time.
3. They are of porcelain, or well seasoned wood, filled, to prevent absorption of moisture.
4. They are so arranged that wires of opposite polarity, with a difference of potential of 150 volts or less, will be kept at least two and one half inches apart, and that there a higher voltage is used, this distance be increased proportionately.
5. There is a backing provided, of wood at least half an inch thick, well seasoned and filled, to prevent absorption of moisture.

METAL STAPLES must never be used to fasten conductors unless

1. Provided with an insulating sleeve or saddle rigidly attached to the metal of the staple, and having such strength and surface as to prevent mechanical injury to the insulation of the conductor.
2. Under conditions in which cleatwork would be acceptable or where driven into a molding specially adapted for open work.

SPECIAL WIRING.

Wherever conductors cross gas, water, or other metallic pipes, or any other conductors or conducting material (except arc light wires), they should be separated therefrom by some continuous non-conductor at least one inch. In crossing arc light wires the low-tension conductors must be placed at a distance of at least six inches. In wet places an air space must be left between conductors and pipes in crossing, and the former must be run in such a way that they cannot come in contact with the pipe accidentally. Wires should be run *over* all pipes upon which condensed moisture is likely to gather, or which by leakage might cause trouble on a circuit.

In breweries, stables, dye-houses, paper and pulp mills, or other buildings specially liable to moisture, all conductors, except where used for pendants, must be:

1. Separated at least six inches.
2. Carefully put up.
3. Supported by porcelain or glass insulators.

Moisture proof and non-inflammable tubing may be accepted in lieu of such construction.

No switches or fusible cut-outs will be allowed in such places.

INTERIOR CONDUITS—Must not be :

1. Combustible.
2. Of such material as will be injured or destroyed by plaster or cement, or of such material as will injure the insulation of the conductor, or construction that the insulation of the conductor will ultimately be injured or destroyed by the elements of the composition.
3. So constructed or placed that difficulty will be experienced in removing or replacing the conductors.
4. Subject to mechanical injury by saws, chisels or nails.
5. Supplied with a twin conductor in a single tube where a current of more than 10 ampères is expected.
6. Depended upon for insulation. The conductors must be covered with moisture proof material.

The object of a tube or conduit is to facilitate the insertion or extraction of the conductors, to protect them from mechanical injury and as far as possible from moisture.

Twin tube conductors must not be separated from each other by rubber or similar material, but by cotton or other readily carbonizable substance.

Conductors passing through walls or ceilings must be encased in a suitable tubing, which must extend at least one inch beyond the finished surface until the mortar or other similar material be entirely dry, when the projection may be reduced to half an inch.

DOUBLE POLE SAFETY CUT-OUTS—Must be:

1. Placed where the overhead or underground conductors enter a building and join the inside wires.
2. Placed at every point where a change is made in the size of the wire (unless the cut-out in the larger wire will protect the smaller). This includes all flexible conductors. All such junctions must be in plain sight.
3. Constructed with bases of non-combustible and moisture proof material.
4. So constructed and placed that an arc cannot be maintained between the terminals by the fusing of the metal.
5. So placed that on any combination fixture, no group of lamps requiring a current of six ampères or more shall be ultimately dependent upon one cut-out.
6. Wherever used for more than six ampères (or where the plug or equivalent device is not used) equipped with fusible strips or wires provided with contact surfaces or tips of harder metal soldered or otherwise having perfect electrical connection with the fusible part of the strip.

SAFETY FUSES must be so proportioned to the conductors they are intended to protect that they will melt before the maximum safe carrying capacity of the wire is exceeded.

All fuses, where possible, must be stamped or otherwise marked with the number of ampères equal to the safe carrying capacity of the wire they protect.

All cut-out blocks when installed must be similarly marked.

The safe carrying capacity of a wire changes under different circumstances, being about 40 per cent. less when the wire is closed in a tube or piece of molding than when bare and exposed to the air, when the heat is rapidly radiated. It must be clearly understood that the size of the fuse depends upon the size of the smallest conductor it protects, and not upon the amount of current to be used on the circuit. Below is a table showing the safe carrying capacity of conductors of different sizes in Birmingham, Brown & Sharpe, and Edison gauges, which must be followed in the placing of interior conductors.

Brown & Sharpe.		Birmingham.		Edison Standard.	
Gauge No.	Ampéres.	Gauge No.	Ampéres.	Gauge No.	Ampéres.
0000	175	0000	175	200	175
000	145	000	150	180	160
00	120	00	130	140	135
0	100	0	110	110	110
1	95	1	95	90	95
2	70	2	85	80	85
3	60	3	75	65	75
4	50	4	65	55	65
5	45	5	60	50	60
6	35	6	50	40	50
7	30	7	45	30	40
8	24	8	35	25	35
10	20	10	30	20	30
12	15	12	20	12	20
14	10	14	15	8	15
16	5	16	10	5	10
		18	5	3	5

SWITCHES—Must:

1. Be mounted on moisture proof and incombustible bases, such as slate or porcelain.
2. Be double pole when the circuits which they control are connected to fixtures attached to gas pipes, and when six ampères or more are to pass through them.
3. Have a firm and secure contact, must make and break readily, and not stick when motion has once been imparted by the handle.
4. Have carrying capacity sufficient to prevent heating above the surrounding atmosphere.
5. Be placed in dry accessible places, and be grouped as far as possible, being mounted, when practicable, upon slate or equally indestructible back boards.

MOTORS.—In wiring for motive power, the same precautions must be taken as with the current of the same volume and potential for lighting. The motor and resistance box must be protected by a double pole cut-out and controlled by a double pole switch.

ARC LIGHTS ON LOW POTENTIAL CIRCUITS—Must be:

1. Supplied by branch conductors not smaller than No. 12 B. & S. gauge.
2. Connected with main conductors only through double pole cut-outs.
3. Only furnished with such resistances or regulators as are enclosed in non-combustible material, such resistances being treated as sources of heat.
4. Supplied with globes protected as in the case of arc lights on high potential circuits.

FIXTURE WORK.

1. In all cases where conductors are concealed within or attached to fixtures, the latter must be insulated from the gas pipe system of the building.
2. When wired outside, the conductors must be so secured as not to be cut or abraded by the pressure of the fastenings, or motion of the fixtures.
3. All conductors for fixture work must have a water-proof insulation that is durable and not easily abraded, and must not in any case be smaller than No. 16 B. & S., No. 18 B. W. G., or No. 3 E. S. G.
4. All burrs or fins must be removed before the conductors are drawn into a fixture.
5. The tendency to condensation within the pipes must be guarded against by sealing the upper end of the fixture.
6. No combination fixture in which the conductors are concealed in a space less than one-fourth inch between the inside pipe and the outside casing will be approved.
7. Each fixture must be tested for possible "contacts" between conductors and fixture, and for "short circuits," before the fixture is connected to its supply conductors.
8. The ceiling blocks of fixtures should be made of insulating material.

ELECTRIC GASLIGHTING.

Where electric gaslighting is to be used on the same fixture with the electric light:

1. No part of the gas piping or fixture shall be in electrical connection with the gaslighting circuit.
2. The wires used with the fixture must have a non-inflammable insulation, or where concealed between the pipe and shell of the fixture the insulation must be such as is required for fixture wiring for the electric light.
3. The whole installation must test free from "grounds."
4. The two installations must test perfectly free of connection with each other.

PENDANTS AND SOCKETS.

No portion of the lamp socket exposed to contact with outside objects must be allowed to come into electrical contact with either of the conductors.

CORD PENDANTS—Must be:

1. Made of conductors, each of which is composed of several strands insulated from the other conductor by a mechanical separator of carbonizable material, and both surrounded in damp places with a moisture-proof and a non-inflammable layer.
2. Protected by insulating bushings where the cord enters the socket.
3. So suspended that the entire weight of the socket and lamp will be borne by knots, above the point where the cord comes through the ceiling block or rosette, in order that the strain may be taken from the joints and binding screws. All sockets used for wire or cord pendants should have openings at least equal to one-quarter inch gas pipe size.
4. Allowed to sustain nothing heavier than a four-light cluster, and in such a case special provision should be made by an extra heavy cord or wire, as a mechanical reinforcement.
5. Equipped with keyless sockets as far as practicable, controlled by wall switches. In no case may a lamp giving more than fifty (50) candle power be placed in a key socket on a flexible pendant.

CLASS D.—ALTERNATING SYSTEMS.

CONVERTERS OR TRANSFORMERS.

CONVERTERS—Must not :

1. Be placed inside of any building except the central station, unless as hereinafter provided.
2. Be placed in any but metallic or non-combustible cases.
3. Be attached to the outside walls of buildings, unless separated therefrom by substantial insulating supports.
4. Be placed in any other than a dry and convenient location (which can be secured from opening into the interior of the building such as a vault) when an underground service is used.
5. Be placed without safety fuses at the junction between main and service conductors and safety fuses in the secondary circuits where they will not be affected by the heat of the converter.

PRIMARY CONDUCTORS.

In those cases where it may not be possible to exclude the transformers and primary wires entirely from the building, the following precautions must be strictly observed :

1. The transformer must be located at a point as near as possible to that at which the primary wires enter the building.
2. Between these points the conductors must be heavily insulated with a coating of moisture-proof material, and, in addition, must be so covered and protected that mechanical injury to them or contact with them shall be practically impossible.
3. The primary conductors, if within a building, must be furnished with a double pole switch, and also with an automatic double pole cut-out where the wires enter the building, or where they leave the main line, on the pole or in the conduit. These switches should, if possible, be enclosed in secure and fireproof boxes outside the building.
4. The primary conductors, when inside a building, must be kept apart at least 10 inches, and at the same distance from all other conducting bodies.

SECONDARY CONDUCTORS.

The conductors from the secondary coil of the transformer to the lamps or other translating devices must be installed according to the rules for "inside wiring" for "low potential systems."

CLASS E.—ELECTRIC RAILWAYS.

POWER STATIONS.

All rules pertaining to arc light wires and stations shall apply (so far as practicable) to street railway power stations and their conductors.

RAILWAY SYSTEMS WITH GROUND RETURN.

Electric railway systems in which the motor cars are driven by a current from a single wire, with ground or floor return circuit, are prohibited *except* as hereinafter provided:

1. When there is no liability of other conductors coming in contact with the trolley wire.
2. When the location of the generator is such that the ground circuit will not create a fire hazard to the property.
3. When an approved automatic circuit breaker or other device that will immediately cut off the current in case the trolley wires become grounded is introduced in each circuit as it leaves the power station. This device must be mounted on a fireproof base and be in full view of the attendant.

TROLLEY WIRES.

TROLLEY WIRES—Must be:

1. No smaller than No. 0 B. & S. copper, or No. 4 B. & S. silicon bronze, and must readily stand the strain put upon them when in use.
2. Well insulated from their supports, and in case of the side or double pole construction, the supports shall also be insulated from the poles immediately outside the trolley wire.
3. Capable of being disconnected at the power house, or of being divided into sections, so that in case of fire on the railway route the current may be shut off from the particular section and not interfere with the work of the firemen in extinguishing the flames. This rule also applies to feeders.
4. Safely protected against contact with all other conductors.

CAR WIRING.

All wires in cars must be run out of reach of the passengers, and shall be insulated with a waterproof insulation.

LIGHTING AND RAILWAY POWER WIRES.

Lighting and power wires must not be permitted in the same circuit with trolley wires with a ground return, except in street railway cars, carhouses and power stations. The same dynamo may be used for both purposes, provided the connection from the dynamo for each circuit shall be a double pole switch so arranged that only one of the circuits can be in use at the same time.

CLASS F.—BATTERIES.

When current for light and power is taken from primary or secondary batteries, the same general regulations must be observed as apply to such wires fed from dynamo generators developing the same difference of potential.

CLASS G.—MISCELLANEOUS.

1. The wiring in any building must test free from "grounds" before the current is turned on. This test may be made with a magnet bell that will ring through a resistance of 20,000 ohms, where currents of less than 250 volts are used.
2. No ground wires for lightning arresters may be attached to gas pipes within the building.
3. All conductors connecting with telephone, district messenger, burglar alarm, watch clock, electric time and other similar instruments must, if in any portion of their length they are liable to become crossed with circuits carrying currents for light or power, be provided near the point of entrance to the building with some protective device which will operate to shunt the instruments in case of a dangerous rise of potential, and will open the circuit and arrest an abnormal current flow. Any conductor normally forming an innocuous circuit may become a source of fire hazard if crossed with another conductor through which it may become charged with a relatively high pressure.

A. J. DECAMP,
Chairman,
M. D. LAW,
STEPHEN E. BARTON,
WM. BROPHY,
T. CARPENTER SMITH.

Certain questions have come before the committee which they considered of too great importance to be decided at this stage. Among these are the subjects of the grounding of the neutral wire in compensating or three-wire systems; the grounding either permanently or by automatic cut-outs of the secondary wires in transformer systems; the adoption of a uniform alloy for fusible cut-outs, and the adoption of better methods for testing circuits.

From the nature of the electrical business and the rapid advance it is making, there must, of necessity, questions continually arise which can only be decided by a later and larger experience: therefore the object of the Association would be best served by the appointment of a permanent committee to whom should be referred all such questions, which they shall consider and report upon at the next succeeding meeting of the association.

Your committee, therefore, offer the following:

Resolved, That a committee of five be appointed by the president to be a permanent committee on safe methods of construction and operation—any vacancies that may occur on the committee from time to time to be filled by the president.

WM. MCDEVITT,
T. CARPENTER SMITH,
WM. BROPHY,
M. D. LAW.

Mr. C. J. Field then read the following paper:

ELECTRIC RAILROAD CONSTRUCTION AND OPERATION AND A CONSIDERATION OF THEIR CONNECTION WITH CENTRAL STATION INTERESTS.

By C. J. Field.

The advantages of the electric railway have passed beyond the age of experiment or question. They are proved by their development in the past four years, and any argument as to their advantage in the general development of street railway practice or suburban rapid transit is antedated. It took several years to convince old staid financiers and directors of the larger street railway properties that it was to their financial advantage to throw in the scrap heap several million dollars, more or less, in equipment and spend that amount in addition and still make it pay; but they have seen this advantage in the development and increase of traffic and returns to their company. These returns have been brought about principally by the development of rapid transit in the introduction of electricity and the flexibility of the system in adapting itself to all and any conditions of commercial practice.

In looking over the past four years of practice in electric railway work, we have much to commend and considerable to condemn. The boldness of the achievements, the problems that have been solved, the rapidity of development and the perfection of the apparatus, seem almost beyond comprehension. That this apparatus, in less than four years, should reach the high state of perfection, economy and efficiency that it has, as compared to the long years of develop-

ment of other mechanical appliances, is remarkable. The natural consequence of this large amount of work and development in this short time is that there has been much work done that had better been left undone in the way of poor engineering, cheap work, and not a proper appreciation of the problem to be solved. These, in some poor instances, have retarded the development and progress of electric railway work in their vicinity, but street railway companies have now come to a proper appreciation of the necessity of good work well done and that the wisest and best method is to consider carefully what will bring the best return for the money invested—not necessarily on the blind basis of the highest cost being the cheapest, for money can be wasted in this way as well as others. We have examples now in several directions of large equipments being installed on a sound engineering basis and with careful consideration of the best interests of the electrical interests, street railway owners and public combined, and we can safely add that there is no problem in this line which cannot to-day be taken up with a full assurance of practical solution and successful development in electric railway traction.

The future outlook of electricity in the development of rapid transit, inter-suburban, and even express service, is assured. We are coming now to the solving of the larger problems in this work and bringing the public to a proper appreciation of the resources and possible achievements in this line and its superiority over the old fogy systems of the past. We even see a considerable number of our friends from cable engineering lines of street railroad work coming over into the electrical fold, fully appreciating that the cable system has a very limited field for successful development and that electric traction is very broad gauge in the field of engineering work. Therefore, with this outlook, better construction work, better engineering, better mechanics, the solving of these larger problems are assured, and we see even to day, in a number of cases, electric suburban traffic supplanting steam on a cheaper, better and more successful basis. The favorable report of the New York Rapid Transit Commissioners has done much to add to public confidence in this direction. Electric manufacturing companies are assisting the development of the work by making their apparatus more substantial, better in construction and more satisfactory in its mechanical design and operation. The reduction in the speed of the motors, the development of single reduction and even of direct connected motors, is doing much to add to the confidence in this line.

We hear asked sometimes, by laymen, the question: "What speed can electricity obtain in railway work?" The able consideration of this subject in several papers, and practical experiments as well, enables us to reply very briefly but confidently to this inquiry, that speed and power in electric railway traction are only limited by road-bed construction; in other words, any speed is obtainable within the range of possibility, with the maintenance of proper track. We do not intend, however, to generally review electric railway work, but more particularly to give some details of the practical problems in construction and operation, and, therefore, we will leave the consideration of other parts of the subject to papers which will, no doubt, treat it more fully.

The consideration of the best development in the power generation of electric railway work has been one that has received considerable attention in past years from the best engineers in this line. We reach here a part of the problem which requires much more careful consideration than has been given steam power in electric lighting generally in the past. The work to be successfully done by the steam engine in the generation of electricity for the operation of railroads is the severest kind, and can be compared only to that of the engine operating rolling mill trains. It is owing to not fully appreciating this fact that we hear in some parts of the country of failures of steam plant on this kind of work. Electrical manufacturers are assisting the solution of this problem by building the larger generators in units of 200 to 400 or 500 h. p. What we want in the generating station for electricity is the smallest division of units consistent with the safe and economical operation of the station. Following the problem out on this line, we can build a successful station; and we would add to this that each unit should be entirely independent and separate from all other units, thereby increasing the reliability. This cannot be obtained in a safe and economical way by the use of our old friend, the countershaft. Undoubtedly, the countershaft has been of much use in electric lighting service, and particularly in arc lighting, but in railway work, with large generators, we can see no excuse at the present time for its use. Generators should be belted directly to the engines, whether Corliss or high speed, or else coupled directly to the engine shaft. With a Corliss engine of 500 h. p., operating at 80 or 90 turns, with a flywheel 18 to 20 feet in diameter, we can belt with belt centres of, say, 40 feet 2 inches, generators of several different commercial types; this gives us advantages which we have heretofore had only in high speed engines with direct connection. The engines should, in any event, as heretofore stated, be extra heavily built for the work to be done, with ample flywheel capacity. On engines of this size and speed a flywheel capacity of approximately 600,000 pounds is about right. On engines operating about 150 turns, say, 30,000 to 40,000 pounds.

High speed engines in the development of railway work have received in some cases a setback, owing to the engine manufacturers not appreciating fully the conditions and necessity of the work undertaken. So-called high speed or automatic engines can be as successfully operated on this class of work as any other, if they are specially built for it. This means larger parts, bearings of more ample size and length and ample fly-wheel capacity. On a cross compound engine of, say, 300 h. p., there should be about six to eight tons in the flywheels, the bearings seven or eight inches in diameter and 15 or 18 inches in length. (Such a type of engine is being furnished by the manufacturers of the Ball engine.) In the case of engines built in this manner there can be no fault found with their operation. A type of engine, which we believe is going to be largely used on this class of work, as well as lighting work, is one that will come in between the high speed engine and the Corliss and which will combine many of the advantages of both. Such an engine has been sought for by many engineers and has been attempted by a number of builders. To-day, however, we cannot find it on the commercial market. This engine, in units of 500 h. p., would run at a rotative speed of about 140 or 150 revolutions and with a piston speed of about 650 to 700.

The question which has troubled most engine men in regard to the high speed engine with a single valve, covering this kind of practice, has been a question of valves and clearances. Beyond any question, when it comes to this size, we have got to come to the Corliss practice of double valve, thereby reducing the clearances and bringing it down to the extent of the Corliss practice. The writer's company is having built, for the electric railroad at Buffalo, two engines of this class, by the Lake Erie Engineering Works, which we believe will do much to develop this line of work, and, also, will be particularly adapted for coupling directly to the engine shaft. The trouble in this line has been to get electric manufacturing companies to take up the building of large multipolar generators adapted for direct coupling at a speed of from 100 to 200 revolutions. This problem was developed on a much smaller scale in this country, for marine plants, several years ago. We find that in Europe, where their work has been more special, that they have successfully developed this type of engine and generator, and beyond any question, it is going to be both for lighting work and for railway work the type of unit for central station practice in the future. It means, where the vertical engine is used, the installation of the steam and electric plant in the space formerly used for engines alone. This means reduction in the cost of building, operation and maintenance.

In concluding this part of our subject on steam generation, we trust that our experience in the past in lighting will show us the fallacy of poor steam engineering, and that we will build our stations for the future, and not have the problems before us that nine-tenths of the electric lighting stations have to day, which mean, that in order to get down to commercial economy and competition, they have got to rebuild their whole outfit. We will merely append to the consideration of the steam plant part of our problem a few interesting figures and data which the writer collected for presenting to street railway companies, in order to give them some useful information in this respect. We believe that they may be well introduced here. The figures given on the table, etc., are not ones that the manufacturer of an engine would tell you were those of the best economy for his engine or plant, but they are figures which will be appreciated by station owners and railway companies as those which are obtained in every day commercial tests.

The relative commercial economy of engines and cost are as follows:

Type.	Lbs. of coal per h. p. hour	Cost per h. p., sizes over 100 h. p.	
High speed single	4 to 5	$11 to $13	This is based on an evaporation of 9 lbs. of water per lb. of coal.
" compound	3 to 3½	14 to 16	
" com. cond	2¼ to 2½		
" com. triple	1¾ to 2	18 to 22	
Corliss single	3½ to 4	16 to 18	
" compound cond	1⅞ to 2	22 to 25	
" triple	1½ to 1⅝	27 to 30	

There are four classes of boilers:

1. Horizontal return tubular, which is the most general in use, and costs $9 to $10 per horse power.

2. Vertical tubular (Corliss or Manning) which is a vertical tubular boiler with water leg, giving an internal firebox, economical in floor space, largely used throughout New England. Cost $10 to $12 per horse power.

3. Sectional or water tube boiler, of which Babcock & Wilcox is the best known, especially adapted for higher pressures and safety. Cost $17 to $19 per horse power.

4. Scotch type of marine boiler—one that has not been used to any extent as yet in station work—but we believe it will be as an offset to the sectional type, and fulfilling the requirements for higher pressure and economy of space.

The capacity of engines requisite for different generators at a steam pressure of 100 pounds:

Generator.	Engine.						
		High Speed.			Corliss.		
Watts.	Horse-power.	Size.	Speed.	Wt. 2 fly-wheels.	Size.	Sp'd	Wt. 2 fly-wheels.
50,000	75	12 × 12	280	7,000 lbs	.....	.....	.....
80 000	125	15 × 16	225	9,000 lbs.	.....	.....	.....
150,000	225	18½× 18	200	15,000 lbs.	20×36	90	25,000 lbs.
2,150,000	450	.....	.....	.....	24×48	80	50,000 lbs.

The cost of steam plant complete is about $50 to $60 per horse power for high speed, and $65 to $75 per horse power for Corliss.

The question of the best electrical generating plant for railway work is one which is allied closely to that of steam plant, particularly in relation of the generators to that of the engines. In some respects, in treating of the steam plant, we have intimated what our idea was in connection with the generators. All large generators of from 200 to 500 h. p. connected as directly as possible, either by direct belting or shaft coupling, with the engines operating the same. It is only by this development that the safest and best solution of electric railway station practice—in fact, station practice in general—can be reached. Manufacturers of railway generators have had an experience extending back many years. That experience in the development of direct current incandescent machinery, although not of quite the same voltage, has led the way up to the safe, economical and commercial development of railway generators; and we find the railway generator of to-day one of the most perfect and reliable factors in the electric railway system. The only problem remaining to be solved in this connection is to build them in larger types and have slower speed for direct shaft coupling. Generators on this work are subjected to the severest and most excessive strain, particularly where of small type, but the building of them in larger units is going to remove, to a great extent, the question of the overloading of the machine. Railway machines are often subjected to an overload of from 25 to 50 per cent. In general these are only momentary, and we find most of them able to stand up to the work to be done.

The question which puzzles many of the railway companies, as well as the electric companies, is what amount of generating capacity is necessary for the operation of a given number of cars. This question, of course, has got to be carefully considered in connection with each case, but there can in a general way be laid down an approximate basis for this work. Some railway companies, in order to show a higher economy than their competitors, are unwisely claiming the requirement of a smaller amount of power than others; but the wisest manufacturer is the one who urges his client to install a larger amount of power than is barely required for the successful operation of the road under any and all conditions. For if any one thing will lead the public to condemn the electric railway traction it is a lack of power, thereby causing the cars to move slowly, and in case of any accident, disabling part of the power. A fair basis on general conditions for 16 to 18 foot car bodies is 20 to 25 h. p. per car, which, with a properly designed and constructed plant, will give the desired power. The cost of generating this power for railway work for 16 and 18 foot cars is three to five cents per car mile for all expenses of the generating station. In some roads we find that cars of a larger size than these do not necessarily take a proportionately larger amount of power. We find from practical experience that a car 32 or 33 feet long, double the size of the 16-foot car, takes, under general conditions, about 50 per cent. more power, and we find by the same experience that a trail car adds about 50 per cent. to the amount of work to be done on the motor car for the same size. As to the minimum and maximum amount of power taken on an electric car, we find that a general average for a 16-foot car, under ordinary commercial conditions, without excessive grades, is one horse power per car mile per hour; or, a car operating at an average 10 miles per hour means an average of 10 horse power per car. This same car will give, however, on a load diagram, taking all its conditions, from maximum to minimum, a variation of from nothing to 50, 60 or even 80 horse power. This gives us an idea of the severe strains and conditions to which an electric motor is subjected.

One of the questions on which we find more variety of opinion than any other is what is the best size, type and style of car for given cases and conditions. The old standard 16-foot car body we find is now being widely departed from, and the problem is, How large a car can we get on a single truck with four wheels without excessive destructive effect on the roadbed? and, What is the longest car we can operate on street car service economically on an eight-wheel base? We believe the limit is reached with a single truck in a 20-foot car body; we know that the truck manufacturers claim in some cases to operate a longer body, but we do not believe it wise. An 18 or 20-foot car running under close headway we believe to fulfill best the conditions of city traffic in the larger cities. Such a car, with a wheel base of seven feet, and in some cases seven feet six inches, where curves are not too sharp, will give satisfaction, and not be too severe on the roadbed where the same is properly constructed. As to the difference in effect on the roadbed between the electric car and the horse car, it is briefly that the horse car is pulled by horses, from which it receives a balancing power and a steady pull, whereas an electric car is operating itself by a power moving the wheels against the track, having no steadying or balancing power from the pull of the horses, and transmitting all its power and moving itself through the wheels. We find, therefore, that it subjects the track to a very severe pounding, necessitating a much better construction of roadbed, practically equaling that of a steam railroad.

Some companies have favored the use of a vestibule on street cars. We believe, though, that any vestibule is a failure and a misnomer. It accomplishes no good and causes much trouble. A shield over the dashboard for the motor man in winter weather would give all that would be required. What is wanted on a street car is that which will allow the freest ingress and egress from the car for the passengers, and anything that retards this—and a vestibule most certainly does—is a detriment and an obstacle to rapid transit. On some roads we have tried the introduction of even larger cars, say, 28-foot body, or 36 feet over all. Such a car, of course, has to be put on a double truck. These cars have found favor with some companies when first considering the problem. The difficulty with them is in getting the passengers in and out of the cars as quickly as possible, and making too many stops, due to the larger number of passengers carried. For inter-suburban heavy traffic, with few stops, we believe such a car would fulfill the requirements, but only in such a case.

Thus, having gone over the question of the cars, we come to the consideration of the electric equipment for the same. To-day we find the double reduction motor discarded, as far as any new equipments are concerned. All the large electric manufacturing companies are placing single reduction motors on the market, and they are in successful commercial operation. One company is placing on the field a motor directly connected to the shaft and without any gearing—in other words, there is no reduction in speed, the speed of the armature being the same as that of the wheels. The same is accomplished by a very ingenious arrangement. We have heard asked in the past the question, Why was it necessary to place 30 h. p. to operate an electric car to do the work that two horses had done formerly? The answer is: The two horses did not do the work in a proper manner and give rapid transit. The life of a street car horse is very short, and we find under

general conditions that 30 h. p. with two 15 h. p. motors has been found about right; in fact, we even find the companies tending towards a larger installation of power, particularly when using larger than a 16-foot car body, and we find to day, being installed for rapid transit in inter-suburban work, 40 and 50 h. p. electric equipments per car, many of them operating at a speed of 30, and even 40, miles per hour. As the amount of power is directly proportionate to the speed, we can readily see the requirement for such an amount of power. The cost of a single car equipped, including the car body, truck and motors, is from $3,000 to $3,500, and the cost of the electric part of the power-generating plant is from $35 to $45 per horse power.

We find in the past about as great a development in overhead and line construction for electric work as in any other part of the subject. While formerly this was one of the greatest sources of unreliability in the operation of the plant, today it has reached a very practical development. Formerly the trolley wires were too light, the feed wires were insufficient to furnish power, and the line was giving trouble, grounding and breaking continually. In the insulation of a single trolley system, with one side of the system grounded, we have the most severe requirements that it is possible to obtain in any electric insulation, in that any grounding on the other side of the system means trouble in the operation of the road. This has led to the introduction of double and even triple insulation into our line material to properly protect the trolley wire from grounding. Where streets are wide enough to spread the tracks to six feet and six feet six inches within the near rails we see introduced in many places centre iron poles, which make a considerably stronger style of construction than cross suspension. There are not many streets, however, where street cars are in operation that are wide enough, or where the city will allow the spreading of the tracks to this distance, and in closer proximity it is not safe to operate with centre poles. On the work installed by the Field Engineering Co., in Buffalo, we find the most extensive system of overhead and underground construction in operation anywhere. Here all the feed wires, with a few exceptions, are placed in underground conduits, thus removing all cause for objection to the unsightliness of a large number of feed wires overhead. These underground feed wires are connected to the overhead wires from junction boxes up the poles.

The cost of overhead construction may be about summarized as follows:

Line construction per mile, complete, including track bonding, plain pole work, cross suspension or bracket with feed wire	$2,000 to $2,500
With sawed and painted poles	2,500 to 3,000
Iron poles, cross suspension, concrete setting, double track, feed and guard wires	6,500 to 7,500
Same with centre poles	4,500 to 5,500

We also append a table which will give a general summary of the cost of electric equipment of street railway systems, omitting the track construction, which, of course, varies with the number of miles to be equipped.

COST OF ELECTRIC EQUIPMENTS FOR STREET RAILROADS.

No. of cars.	Steam plant h. p.	Capacity of generators. K. W.	Steam plant. *	Station electrical equipment.	Car equipments, car trucks and motors.	Line construction ½ mile of double track per car.	Total equipment (omitting track).
6	120	80	$7,000	$6,400	$19,500	$7,500	$40,400
10	225	150	11,000	10,500	32,500	12,500	66,500
15	375	240	17,500	15,000	48,750	30,000	111,250
20	450	300	22,000	17,500	65,000	40,000	144,500
30	675	450	28,000	22,000	97,500	90,000	237,500
50	1,125	750	50,000	33,000	162,500	187,500	433,000
100	2,025	1,350	90,000	60,000	325,000	375,000	850,000

The above figures are approximate only and based on the best city railroad practice.
* Add 25 per cent. to these figures for Corliss.

The track of street railway companies before the introduction of electricity was more behind the times than any other part of their equipment. The old flat rail is antiquated and antedated, and in a few years its use will be obsolete. The necessities of electric railway traction—in fact, of any traction—have impressed upon the street railway companies in their equipments the requirement of a good roadbed for the successful operation of a road, and we find this part of the problem receiving much attention as any with companies who appreciate fully the work before them. The general construction to-day is girder rails of from 60 to 80 pounds per yard placed on chairs where block paving is in use, with ties 2½ to 3 feet between centres. We find in some cases even 90 and 100 pound rails used, but we believe in more moderate weight for the rails and the ties placed closer on centres. We believe this has been the general experience in railway work. Such a style of construction costs from $9,000 to $10,000 per mile. In suburban roads, on streets where there is no paving, we find the T rail being used; the roadbed can be properly constructed on this basis with 45 to 50 pound rail, for $6,000 to $6,500 per mile, the rail being spiked directly to the ties.

In order to make a summary of the data and figures, I will summarize them in a practical example.

I propose to take, as the best means of illustrating practically, the purchase, equipment and operation of a street railway system with electricity, a city with a population of say 100,000—with a dilapidated street railway system, earning a gross income of $125,000, to purchase same for $500,000—property rights, franchises, etc., and equip it with 40 miles of single track and 65 electric cars.

COST OF EQUIPMENT.

Steam plant (1,500-h. p. steam plant):		
Five engines, 250 h. p. each, compound condensing, size 16 inches × 32 inches × 42 inches, with wheels weighing 30,000 pounds		$32,500
Eight R. T. boilers, 7½ inches × 16 feet		9,600
Jet condensers		3,000
Two boiler feed pumps		900
Steam and exhaust piping		12,000
Five engine foundations		8,500
Eight boiler settings	3 200	
Five 30-inch belts	2,000	
Erecting and starting	3,500	
Freight and miscellaneous	2,500	
		$72,700
Electrical plant:		
Five generators, 200 kilowatts, $7,500	$37,500	
Switchboard installation, foundations, etc	4,000	
		41,500
Building:		
Power station, including stack, traveling crane, etc	$25,000	
Car house and repair shop, including tools, etc.	15,000	
		40,000
Track construction:		
40 miles girder rail construction, ties 2½ feet centres, 63-pound rail, etc., $1.15 per foot	$244,380	
Relaying, including paving, etc., at 60 cents per foot	126,720	
Trucking, hauling, etc	24,000	
Ties, including 10 per cent. of joint ties, 130,000 at 40 cents	52,000	
Ties, including 10 per cent. of joint ties, 15,000 at 70 cents	10,500	
		456,100
Line construction:		
Ten miles iron poles, etc	$75,000	
Ten miles wooden poles, etc	40,000	
		115,000
Car equipment:		
65 electrical equipments at $2,000	$130,000	
65 car bodies, 18-foot body, with open ends	65,000	
65 trucks at $250	16,250	
		211,250
Summary:		
Steam plant	$72,700	
Electrical plant	41,500	
Building	40,000	
Track	456,000	
Line construction	115,000	
Car equipment	211,250	
		$936,550
Superintendent's and engineer's work	$50,000	
General and miscellaneous	50,000	
		100,000
		$1,035,550
Original purchase		500,000
Total cost re-equipped		$1,535,550

Gross income, say, $350,000,

Net income, say 35 per cent., equal to 8 per cent. on cost, on the basis of an investment of about one million and a half of dollars, and from a property which in many instances was hardly earning its fixed charges formerly.

We have here illustrated a practical example of what is being done every day in this country at the present time in the purchase and equipment of street railway systems. In fact, we find a large number of bankers and capitalists giving it their earnest attention as one of the best fields for investment at the present time.

We desire to call the attention of central station owners to the profit to be made from the furnishing of power in street railway operation, and also by the combining in smaller towns of the street railway companies and electric light companies. The trouble in most cases in central stations obtaining contracts for power, outside of small roads, has been to convince the railway companies that the electric light station can economically and reliably furnish this power, and we must say that in many cases their fears are well founded. Therefore, it behooves the central station companies to place their generating plants and station, not only for their own business, but for this added business, in such a shape as to remove this objection. There is no reason why electric light stations should not do a large and profitable business in this line as well as in stationary motor work, for the same factor is introduced here and the same reasons why they can safely and profitably furnish this power: if they have a station properly built, and large enough to add this power, that factor is established. If they have a proper station operating force, in many cases this force need not be added to at all. As to what basis this work can be properly done on, we hesitate to state figures, except in specific cases, but will try to give a general idea of some of them. For many small roads power contracts have been taken at so much per day, assuming a basis of 100 to 125 miles operated. Such contracts have been at from $3 to $5 per car. The regular basis, in accordance with which most street railway companies make their contracts and desire to base their cost of operation, is the unit of car mile operated; therefore, most contracts are on this basis. This comes down, therefore, to a basis of from three to five cents per car mile; the latter figure we consider excessive, and one which would be only made by any company for temporary necessities. We know of cases where the matter has been carefully considered and the plant properly installed for it, where contracts have been made for between 2½ and 2¾ cents per car mile for 16-foot cars, on roads with grades not exceeding 1½ to 2 per cent. In this case, and, in fact, in most cases where the closer figures prevail, the railway company furnishes the generators and the station owner furnishes the steam power and all expenses of both steam and electric power due to ordinary wear and tear. A profitable source of investment has been found in the more moderate sized towns of, say, up to 30,000 or 40,000 inhabitants, in the installation of combined electric railway and lighting stations; the companies either equipping new ones or purchasing old street railway systems and dilapidated lighting plants running on an unproductive basis, but which have a good franchise and field for business. Such companies have proved very profitable, as the combining of the operating expenses for railway and lighting station has done much to reduce expenses, and in many cases one manager or superintendent has proved sufficient for the entire system.

What we have tried to prepare here has been, not a paper which will be so attractive to merely read, but in which will be combined a certain amount of data information which will be of use in the further consideration of the problems herein outlined, and trusting that, if we have accomplished nothing else, we have led you to a profitable line of thought, it is respectfully submitted.

Mr. BURLEIGH: The paper is an exceedingly interesting one to me. I would like to ask what service is rendered by the local lighting company for the three cents per car mile?

Mr. FIELD: The actual service is to operate the generators which the street railway companies should install. I believe that the street railway company should install its own generators, because I believe that questions will arise about accidents happening to the generators, and the station should only be responsible for ordinary wear and tear—not accidents due to short circuiting, lightning or other causes. That, I think, is the most satisfactory basis for this kind of business.

Mr. BURLEIGH: The loss of an armature in that case would be borne by the street railway companies.

Mr. FIELD: Yes, sir.

Mr. BURLEIGH: Then this three cents per mile is for current?

Mr. FIELD: For furnishing the steam and the labor: There are some cases where the current has been contracted for for four or five cents, temporarily—in Boston, where the West End Company, owing to delays in building its car-house, has had to contract with companies that could not afford to furnish it at any less than four or five cents per car mile.

Mr. BURLEIGH: I would like to ask Mr. Field if he advises central station men to attempt the care of overhead lines, the electrical part of the car equipment, etc.

Mr. FIELD: In general I would say no. I think that is the street railway companies' own business. Any street railway company that is running on a proper basis should have an emergency gang to take care of its own line. I do not believe in a central station manager attempting any more than he has got under his direct care now, and that is the furnishing of power from his station.

The convention then adjourned until the next day.

FIFTH SESSION.

The association met for the fifth session on Friday, Sept. 11, at 10 A. M.

The first business on the programme was the paper of Mr. J. L. Ayer, of St. Louis, entitled "Some Details of the Care and Management of an Arc Light System as Practiced in the 'Municipal,' of St. Louis." The paper was as follows:

SOME DETAILS OF THE CARE AND MANAGEMENT OF AN ARC LIGHTING SYSTEM AS PRACTICED IN THE "MUNICIPAL," OF ST. LOUIS.

By James I. Ayer.

As central station men, it seems to me that we should demand of each other as much knowledge of the practice and experience as it is practicable to give. In fact, if this association is to be useful, our meetings should be largely "experience meetings," and the practical experience of those engaged in the development of the lighting and kindred industries, if given liberally at each meeting, would be followed closely by those interested in the production of electrical apparatus and supplies, and would do much to advance the business and improve appliances. Believing that we are here, as central station managers, for mutual improvement and for the free interchange of ideas and experience, I have presumed to present you with a limited, though doubtless dry, outline of the practice which obtains in the central station under the writer's charge.

The station, as designed, has a working capacity of 6,000 arc lights, and is now operating daily 3,500, and about 200 constant current motors. Two thousand of these lights are distributed over an area of 60 square miles, suspended between and from poles 50 and 65 feet in length, at a height of from 35 to 50 feet above the roadway, an avearge distance apart of about 900 feet, and used for street lighting. The motors and about 1,500 lamps are operated for the usual varied service of private consumers. Sixty-nine circuits supply the lamps and motors, containing about 1,200 miles of wire and supported on 12,000 poles.

For generating the current, we have six 600-h. p. Corliss engines, which drive 300 feet of shafting, from which are driven sixty-five 60-light, and twelve 80-light, 2,000 c. p. arc dynamos. The arrangement of the dynamos is such that we have ample room for the care of 85 machines on a floor space of about 100 × 45 feet, and are able to operate a large number of dynamos with a very limited amount of help. Four boys and one young man of very limited experience care for all the machines during the night, in an entirely satisfactory manner; while a suitable man, with three assistants, give the necessary care to the dynamos during the day.

Thirty-one trimmers, with horses and carts, travel about 500 miles a day to renew the carbons in the street lamps. The average number of lamps to each of these trimmers is 68. Sixteen trimmers care for the 1,500 commercial lamps. Five inspectors, or troublemen, with carts and horses, care for the lines night and day, answer fire alarms, locate faults and correct minor troubles on the lines. Two day and two night inspectors care for the commercial arc and 2,500 incandescent lamps. A stable of 20 horses, in addition to the 40 horses owned by the trimmers and inspectors, is required. The maintenance of 60 vehicles justifies a blacksmith and wagon shop, which, with the stable, require the service of eight men. Two men care for the shafting and three engineers and four oilers for the engine room. In the boiler house, where there are nineteen 300-h. p. boilers, there are two pump men, with two assistants, twelve stokers, one boiler cleaner, and six coal shovelers. These, together with an average force of 35 line and ground men, foremen, chief trimmer, chief inspector, superintendent of lines, store keeper, repair shop employés, carpenters, clerks, etc., constitute a force of about 170 men. A very large per cent. of these men are called upon to perform duties which are simple, yet, because of their extreme newness, are not thoroughly comprehended by them. To get the best results, each man requires clearly written rules, as few of them as possible and their rigid enforcement. In all practice this is the wise way to put it; but it is absolutely necessary that it be so with a large force, where many of the men do their work independently and free from the constant supervision of a foreman.

In the room used as an office at the station by the inspectors and foremen are city maps, mounted on boards, where the locations of the lamps are indicated by tacks and the circuits by strings. For the central part of the city, where there are many circuits on the same line of poles, each circuit is shown on a separate map of that section. A number of printed slips, which represent a pole with cross arms, indicate the location of the wires on the poles on the different streets traversed by the different circuits. Any change of circuits is noted on a separate blank when the work is ordered, and when completed the maps are corrected to correspond. It takes but a few days for a man to become quite familiar with the circuits, by keeping them so conspicuously placed. In large stations this method of indicating circuits is almost indispensable, and will prove of great value if used in smaller ones.

For testing purposes we have a portable tachometer for indicating speeds, two Thomson indicators for the engines, a recording steam gauge, two standard ammeters and a voltmeter reading to 5,000 volts for the dynamo room; on each circuit a spring socket for attaching ammeters and a current indicator for indicating the direction the current is flowing through the circuit; near the lightning arresters on the upper floor, a switchboard specially arranged for testing only; a wheatstone bridge, magneto bells, etc. The engines are indicated once each day.

Evaporation boiler tests are made every month to see that the quality of coal is maintained at the standard. All the circuits are tested four times each day. All live circuits during the day are tested for grounds, and all others for apparent open circuits as well. In addition to this, all circuits are tested while alive by taking volt and ammeter readings simultaneously. The number of miles of wire and number of lamps being known, any material increase in the energy consumed gives evidence of a fault not always easily discovered by other methods. In testing for grounds on circuits not alive a strong magneto bell is used. For all other testing a battery current of from 30 to 50 volts is used, and the circuit is required to pass at least one ampère to operate an ordinary call bell. When this bell is placed in series with a circuit which has more resistance than will pass this current at the pressure, the circuit is at once inspected and the fault located. In locating the trouble, one side of the bell circuit is connected to the line and the other to earth. The inspector or troubleman carries a similar bell with him, which he connects in series with the earth and line at various points, until the fault is located. The value of circuit testing with low voltage is keenly appreciated by those who have practiced it. When the circuits are alive, ammeter readings are recorded every two hours, and all readings are from the same instruments, These instruments are arranged so as to be read singly or in series, and one is used to check on the other. The value of first-class instruments in plants of any size cannot be overestimated, and should be in daily use in all stations, rather than the makeshifts generally supplied.

The stopping and starting of engines and boilers, pumps, dynamos, circuits, etc., are all recorded on reports made by those in charge of the different departments. Each inspector, trimmer, line foreman, storekeeper, and all heads of departments make daily reports of work done, and time and material used by them. Each trimmer is charged with a certain number of demerits for each fault on his route, such as defective or dirty lamps, broken or dirty globes, carbons used in excess of the required number, etc., and each month prizes are awarded to those having the best records.

The advantage of using vehicles for trimmers for all street-lighting work is being recognized. Provide a man with proper appliances and your service will improve. He cannot carry all that he should and walk long distances, nor will he take the same care when he is worn out with tramping that he otherwise would. We find it desirable for the trimmer to own and care for his own horse, while the company provides a suitable vehicle and harness, which he turns into the stable once a week for inspection, cleaning and repairs, when needed.

We select from our linemen those whom we class as inspectors or troublemen, who are equipped with a light running cart, with a suitable place for the storage of all tools necessary to use in an emergency. In addition to the special duty required of them during storms or at fires, these men correct all minor troubles reported to the office from various sources. During the first year's operations the average time lost, due to open circuits at night—that is, the average time lost from the time the circuit was opened until it was closed and the lights restored—was an hour and five minutes, notwithstanding that all circuits are more than ten miles in length. When these troubles occur, it is almost always during a storm, but the conveyances with which they are provided and their thorough knowledge of the circuits enable them to become very expert in locating and correcting troubles. During the past year nearly 15 per cent. of all the calls answered by our troublemen were to correct troubles on the lines of other companies. Because we have wires all over the city, the police, and the public generally, think that all the wires belong to us, and, when they discover any trouble with them, are very apt to report the same by telephone to our station. During the entire twenty-four hours there is always one man on duty, ready to answer just such calls and correct the troubles.

All arc lamps, before leaving the station, are placed in a test rack, where they are supplied with a current maintained absolutely constant. Voltmeter readings are noted soon after the lamps have been lighted, when the carbons are about half consumed, and also when they are burned quite short. During the early part of the burning the lamp is adjusted so that the readings, taken at three different points, give an average reading of 46 volts. In case of double lamps, this work is carried out on both rods. This extreme care in regard to adjustment we regard as absolutely necessary. If a lamp is permitted to consume its carbons, any fault which would not be discovered by a brief test is quite likely to develop. To determine the length of arc by the current and voltage is more likely to result in uniform lamps than were tested by the eye. With ten lamps, adjusted to burn at an average of 46 volts, with 9-5-10 ampères, the average number of watts per lamps was 436. Without changing the adjustment of the lamps, the current was increased to 9 8-10 ampères, and there was an average consumption of 524 watts per lamp, an increase of 20 per cent. of energy; and by increasing the current to 10 ampères, the average number of watts per lamp was 550, the average voltage 58, the increase above normal being 33 per cent. That means 33 per cent. more coal, 33 per cent. more work at your dynamo, 31 per cent. less capacity in your dynamo and probably 33 per cent. less life in your armature. One is apt to think that the difference between 8-5-10 and 10 ampères, when supplied to the lamp, is only a difference of 5 or 10 per cent., which is not very serious. This would be true if the lamp were adjusted each time for the ampère current it was to be operated with. To those who have not made this experiment, perhaps, a portion of the mystery as to where the coal goes will be cleared up. By using the ammeter and voltameter for adjusting the lamps, and then seeing that the circuits are provided with the same ampère current indicated by the same ammeter, one will be apt to bring about like conditions in all lamps; at least, they are more likely to be uniform than if independent ammeters are used on each circuit. By reference to this statement relative to the amount of energy consumed by change of current, it will be easy to see how expensive one or two low lamps would be on a circuit, where the operator, to correct the trouble, supplies them with current enough to make them bright. Of course it is understood that better service as well is obtained by operating the circuits with no more current than that for which the lamps are adjusted. In this connection, I believe it is proper to again call attention to the well worn subject of connections. A great deal of time and trouble is spent in soldering joints, and when the lines are led to the lamp they are apt to be poked into the binding posts, held with set screws indifferently tightened, and between these binding posts and the lamp connections proper there are perhaps three or four, if not more, indifferent contacts, all of which look very well in the factory, but are very bad after a few months' service. Hanger boards should be used which have the line wire soldered to connections which cannot get loose. In our practice we accomplish this by using about 18 inches of flexible insulated cable, which is soldered to the hanger board binding posts at the station (cut-out boxes are treated in the same manner) leaving the lineman nothing but an ordinary line joint to make, which can be easily done outside. Where lamps are suspended from the hanger-boards by the hooks which conduct the current, we always insist on some character of second connection being made to the lamp besides this. A simple way to do this is to take some small wire and tie the hook to the loop, in much the same manner as you would with a piece of twine. We have no screw connections anywhere in our circuits, and with a little ingenuity and carethey can be avoided always in arc lighting circuits. By the use of a special socket in each circuit for connecting an ammeter, we are able to take the readings with volt- and ammeter, and get a correct indication of the actual consumption of energy on a circuit while in operation. With data relative to the number of lamps in service and the number of miles and size of wire, we are able to discover any excessive consumption of energy and prevent the development of a series of little faults, which, in a short time, grow to be very serious ones if permitted to continue. Usually these readings are taken on each circuit three times a week, and during the time these observations are made indicator cards are taken from the engines. From these two sources we get the actual consumption of electrical energy per circuit and per engine. We also get the indicated horse power. From a set of eleven observations, taken from July 30 to Aug. 28, at various hours during the night run, the station shows an efficiency, between indicated horse power and electrical horse power, at dynamo terminals of 74.9 per cent., ranging from 70.3 per cent., the lowest, to 77.5 per cent., the highest efficiency shown. The circuit readings indicate an average consumption of energy per lamp of about six-tenths of an electrical horse power. The average indicated horse power is about eight-tenths per lamp. A good condition of the circuits is maintained constantly, because any neglect in any department is quickly shown by the data obtained from our records. Some months ago, when press of business caused the measurement of circuits to be neglected for a few weeks, the writer discovered an increase of over 10 per cent. in the consumption of fuel, when there should have been a slight decrease. An investigation showed that an accident to an ammeter had caused a false reading, which increased the cost of fuel alone about $16 a day. The difference in the appearance of the lamps was not such as to call forth special comments then by those interested, yet, when the fault was discovered, it was remembered that some seemed to have been burning high for a week or two. On suburban circuits on long loops it is our practice to place cut-out boxes on the pole where the line branches. This saves a great deal of time in locating troubles; but let me add that unless a thoroughly watertight and substantial cut-out is used, it will prove more of an annoyance than an advantage. A log of each circuit and dynamo, as well as of engines and boilers, is a very satisfactory and desirable part of the records, and will frequently assist materially in locating troubles and saving expense.

Throughout the country it is almost the universal practice to wire for arc lights without cost to the customer. There is no valid reason for this custom, and for more than a year it has been our custom to charge for cost of labor, with the result of reducing expenses more than $600 per month. In every case where lamps are discontinued in the spring, we require a contract for fall and winter service, else the wires are removed when the lamp is taken down. We invariably cut down the line between the house and pole where the service is discontinued for the season, though it is to be renewed later. To induce annual contracts, a rebate of 5 per cent. is given at the expiration of the year, and is found to work to advantage.

There are very many details of construction, as well as of office work, which could be referred to if it were not that this paper is now too long; but I will be glad to furnish a copy of "General Instructions to Employés," used in the government of this plant, which refer to and bring out some points of management which are not mentioned here, to those who care for them.

Mr. Ayer remarked that as his paper was printed and in the hands of the members, he would not take the time to read it, but would make some additional remarks. He said:

One point I touch on in the beginning, where I say that I think that our meetings should be largely "experience meetings." I think you will all agree with me in that statement. The practice we have had here of meeting in the morning-carrying our meetings along until we get through the programme laid out, results in this—that if there is much discussion of the papers, or much interest developed in the matters that come before you here, you delay other matters, and carry the work over very close to some entertainment or into the dinner hour, and this sometimes has been very unfortunate. Yesterday a paper was read here on electric railroads, by Mr. Field, which was full of interest, and yet because of the lateness of the hour at which it was presented many of the members had gone off to take care of other engagements, or to get ready for the excursion on the river, or to get their lunch, and for that reason the thing was neglected. And yet we had a paper then from a man who was giving us just the character of information we wanted, and which was thoroughly practical in its statements. It concerned a matter which is quite as much of importance to us as the subject of any of our papers, and contained information which we all want to get at. We want the central station men to say something. We want to have papers emanating from them which are pertinent to their business. That thought has been suggested to me, and I presume is in the mind of everyone who comes here for information.

In referring to our station, and in giving you this paper, I have done so with the idea of bringing out, developing and inviting other papers of this nature. I want to say with reference to this station of ours that the problem which I had there was different from that of almost any central station that I know of to-day. It was to start in and build a plant of large capacity—to spend money far in excess of the requirements of the station by the business in sight, and to build a station which still had a very large business to start with. We already had a contract with the city of St. Louis for 2,000 lights, and the prospect was when the station was first laid out that it would ultimately absorb other companies, take in a number of smaller stations, as was afterward done; and so my instructions were to build as large a station, on a given piece of ground, which they handed over to me, as I could and regardless of what it cost. I was confronted by a problem in that particular which will explain some of the peculiarities of construction which we adopted. I built a station with a working capacity of 6,000 lights, but when the station was put into operation it commenced with 2,000 lamps. All the stations throughout the country which are in the hands of our members have, as a rule, grown up from small affairs. They started up in some junkshop or other with a few dynamos, and grew as the necessities required, and the result is that there has been an enormous amount of patch-work all the way through. But in our station there is nothing of the kind. We had to start off and build something which would be complete in itself, and which was comprehensive enough to take all the work in the near future that was likely to be drawn into it. Since putting the station in operation we have absorbed the other companies, and brought up the output of the station to the number of lights mentioned in the paper. At the time of building this station there was nothing of its character, size or magnitude in this country. The problem which confronted me, aside from the designing and construction of the station, was the system of management to be adopted, the methods to be applied, the details relative to the management of the men,—and it all had to be worked out and put in motion with the wheels at the beginning. The plan that I outlined, the blanks that I made for the government of my men, are the ones that I am using to-day. I have made but few minor changes in the original blanks that were laid out before we had done any work at all in the way of operating. And while undoubtedly we have followed in detail many of the practices that have obtained in other central stations in the management of our men and in the division of the work, I want to say that I was unable, on applying to a number of cities, to get anything to assist me in arranging our blanks or system. It was a thing that could not be found. I have since found, in conversation with central station men who have large plants, that we have thought out the same ways independently, of managing our stations independently—that we are working on similar lines. In some instances it is peculiar that it is so. One object of the paper in outlining the details of practice at our station is because of the fact that that has not been done very much, and because I realized what difficulty I had in endeavoring to obtain information. In fact, I did not obtain any that was of value to me. That is my excuse in a measure for going into details of our plan of working to such an extent in this paper.

First, I will refer to our method of caring for the street lamps. We have got a number of street lamps distributed over a very large area. The city required that our lamps should be supported very high above the street. The minimum altitude of the lamps is 35 feet above the roadway. The city also required that we should suspend them between the poles. They were arbitrary in the matter. In order to get our lamps at that elevation the shortest pole that we could use was 50 feet in length. In suburban lighting they require the lamps to be 50 feet above the road way, and they have to be suspended from 65 to 70-foot poles, according to the length of the span. The average distance apart is about 900 feet. I think that we have about 1,500 lamps where the average distance apart is 825

feet. The balance of them, 500 or more, have an average distance of 1,300 feet between the lamps. These are long distances. In lighting the suburbs, and, in fact, the whole city, we have found the use of a cart and horse very desirable. As stated in the paper, the average number of lamps per trimmer, with a vehicle, is 68. When one stops and thinks about the work, where lamps are located close together, of easy access, supported by methods which enable the trimmer to get quickly at the lamp, or even supported as mine are when they are placed so high above the streets, that looks like a small number, because we have, as doubtless many others have, some trimmers who care for more than 100 commercial lamps per day. But we have got our lamps at this high altitude, and it takes a long time to raise or lower them. We are compelled to use a device for raising and lowering—a device which has to be lowered and locked in order to prevent its being meddled with, and that necessitates each time the unlocking of the device by the trimmer, applying the crank, lowering and raising the lamp; and as the poles are set on the curb line of the streets, and passing vehicles could knock the device off easily, the hoisting device has to be placed up high out of reach of the sides of the wagons, and that necessitates the use of a ladder by the men to get up to the hoisting device. It seemed to me before we went into operation that it would be essential that we should have something of that sort. We have a cart, modified to suit the requirements, and enabling our trimmers to carry extra globes, extra lamps, rubber clothing, means for keeping the carbons dry, and any number of tools that they wish (and we require them always to carry a few) and to carry the means to enable the trimmer to make any temporary repairs for the purpose of removing any defect or trouble which he may find. We have found that by furnishing our men with cart and horse (requiring them to furnish the horses), we have been able to employ men for $65 per month who are in every way equal to the men whom we employ for trimming commercial lamps, where they carry a stepladder around the town, at $2 per day. For $65 per month we find them seeking the positions as trimmers. They furnish their own horses, feeding, shoeing and caring for them in every particular, leaving us only to supply them with vehicles and harness. The cost of maintenance for vehicles and harness is not very great. The cost of outfit was about $75 per trimmer. The cost of repairs and depreciation of harness and vehicle is about 40 per cent. annually, as we calculate it. That is, it will cost about 40 per cent. of the investment to keep it up. That thing has been discussed somewhat, and in some other places they have tried the use of carts and are not altogether pleased with them, but where the conditions are satisfactory, I must say that we find much better results in the care of our lamps in that way than we have ever experienced with the same class of help. With $40 trimmers, such as we have, I doubt if we could get the results that we do in any other manner. We have got a very useful little blank which I presume may be advantageously used in many other places. We have printed on it a form of telegraph pole with 15 cross arms on it and 10 pins. Although we use no more than eight pins for our work yet we use pole whole lines in carrying our wires over the city, and we keep a record of every pole and wire on those blanks. The location of the pole and the positions of the wires on the pole is indicated on the blank. From the corner of First to Tenth street circuit No. 5 will occupy the two outside pins on the top crossbar, and the side of the street and the name of the street is given, so that by reference to that diagram at any time we know the exact location of our own and of other people's wires. In laying out new circuits and in doing addition work it is a very convenient thing to refer to, and it saves lots of work. It is very convenient where you have many poles, and especially where you have to run a mixed line and interchange with other companies, to have some such arrangement. In the care of a station, it is rarely the practice in the smaller stations to have anything in the way of instruments except those furnished by the parent company, and possibly sometimes one outside instrument. We all know the utter unreliability of the ordinary commercial device furnished to us as an ammeter by these parent companies, and unless you do accurately know the amount of current, leaks will creep into the plant, which I am sure would astonish any one if they were to go at the matter carefully and measure them. I do not think that there is a station in a town of 20,000 inhabitants and over that can afford not to be provided with a high reading voltmeter (I am now speaking exclusively of and referring only to arc line circuits), that will measure the whole difference of potential on your circuits during the operation of them, so that you may know the amount of energy being consumed; and accurate ammeters are essential in order to know what that energy is. In the paper I have made a point of that. I will give you a statement of a little test. Until I had made the test and made the comparison I could not realize that the difference or the opportunity for difference was so great. With 10 lamps adjusted to burn an average of 46 volts with 9.5 ampères of current, the average number of watts of the 10 lamps was 436 per lamp. Now without changing the adjustment of the lamps in any manner, but simply increasing the current so that the ammeter needle read 9.8 ampères (an increase of 0.3 ampère, and you will find that the indicator furnished by our parent companies will not agree within half an ampère), with an increase of current of only 0.3 of an ampère the average consumption or increase of watts was 524, or an increase of 20 per cent. in the watts consumed. That was the result of changing only 0.3 of an ampère. When the current was increased so as to give the lamps 10 ampères we had an average voltage of 55 volts per lamp instead of 46, an average of 550 watts per lamp, or an increase of 33 per cent. in the energy consumed. There is a saving equivalent to a very handsome profit on your lamps. We all know that often in a moderate sized station some one will often come in and think the lamps are not in good order and ask, "What is the matter with the lamps? Push them up." The ammeter is found to be all right, but still we give them more energy. Many of our superintendents want to have good lamps and they want to make a good show with them, and so they keep their lamps bright in this manner. Now they will get just as satisfactory a light and a more even light, by having the lamps properly adjusted and running them on a normal current, than they can possibly get in this manner, and be able to save from 33 to 50 per cent. of the energy consumed in those lamps. This is a point that I know a good many of you have already looked into, and you have discovered in practice that it is an opportunity for very serious leaks, but I have never heard anyone bring it out before. The matter has never to my knowledge yet been before the convention or publicly commented upon. This shows you the necessity of having a good and accurate instrument adapted to your work. Our practice is to take the commercial instruments furnished by the company whose apparatus we use, and then standardize them, regardless of their scale indicating where the needle should stand to indicate the currents that our lamps are adjusted for. We use two Weston ammeters as standard instruments. I find it desirable to have two rather than one. Those we use almost entirely for standardizing these other instruments which we use in practice. There is something very peculiar about an ammeter. I find that they will run along perfectly accurate, and that two or three instruments will agree exactly for a week or ten days, and then without any apparent cause, and when working under identically the same conditions, and collected together in series so as to take the same amount of current, the needle will vary sometimes as much as 0.2 or 0.3 on one instrument. Then we bring in our standard instrument and put it in the series in order to find out which one of those has changed its adjustment. It is something that we do not attempt to account for, grouped as they are, for this occurs in cases where we have them fastened to a board against a post, and where all the influences surrounding them are the same under all conditions and at all times, and they are not in close proximity to any wires carrying heavy currents, and there is no opportunity that I know of for change either in condition or position. And yet the change does occur. I think that money expended for good instruments to be used in adjusting lamps and in maintaining the current constant is money well expended. In operating the large number of lamps that we do, if we had an ammeter on every circuit (as some do) we would have a very variable condition of affairs. Of course these variations in ammeters would exist. We keep continually two ammeters in series. We have a very convenient plug and socket made for inserting the ammeter quickly in the circuit, so as to get it right in circuit. It is placed on the switchboard by simply inserting a single plug. Thus we connect the ammeter in series with the circuit. Our practice is in starting up as soon as the dynamo is in operation, to insert the plug, and see that the current is what we desire to show by this instrument. We go through the whole series in that way, and that thing is repeated in our station every two hours during the night, and during the day time once an hour. We find it desirable to do this. While we have not much change in load we have changes in circuit conditions during the night, and the governors are not always responsive to a moderate change of load. You can easily build up your current 0.1, 0.2 or 0.3 of an ampère, and the governor will not always respond. We burn more carbon and of course more coal during that time. This matter of circuit connection is often a fruitful source of trouble as well as one of the causes of an immense loss of energy, and is a thing that we all ought to pay close attention to. I know that all central station men now make it a practice to make a solid circuit by making good line joints, but when we let out a lamp we are very apt to have a binding post there, and we are apt to insert the wire, in either in the hanger board or on the lamp proper, and the man sets up the set-screw and leaves the lamp hanging there, and then the wire will corrode, and a condition will be brought about which will soon so disarrange things that a 40-light dynamo will run only 30 lights. We use hanger-boards for suspending all our lamps, whether inside in commercial use, or outside in city use. The hanger boards are all provided with cut-offs. But before the boards were put in service—not before they were put in service, for we put our plant in operation very hurriedly—and so we took our boards as they came from the manufacturer—but shortly subsequent to that we soldered a short section of flexible insulated cable to the binding post of each hanger board, and then when the man comes along to make a line connection after the hanger board is put in place, he makes an ordinary line joint. Thus they get a good strong connection. The soldering that is done is done in our repair shop, or done at the station, where they have time to have it done well. Of course a man cannot do a good job out in the wind, and under all the conditione usually existing when he has to solder up a connection of that nature, and where an iron is obliged to be used to solder a wire to binding post. We have all seen cases where cut-outs on a line have soldered joints which had better have been left alone, and even left the solder left off. There is often a lot of acid left on so that the wire is corroded in a very brief time, or they get a little lump of solder piled in one corner. The same practice obtains as to all the devices that we put in circuit. In cut-out boxes we use the best flexible insulated cable, so that it may be put in and out many times, and leave the connection unimpaired. We have those soldered to the hanger board binding post at the station. This leaves the lineman nothing but an ordinary line joint to make, which he can do outside easily and well. I cannot say that that is done on all our circuits, because of the hurried way in which the plant was put in operation and because we put in 1,200 lights at the very outset, and so there is more or less of the old construction which has now been overhauled. But generally we have no connections in our station except solid soldered connections, except where a lamp is connected to the hanger board. We have a hook hanger and also have a binding post on this hook on the lamp. We hook the lamp into the hanger board hook and solder a short piece of cable, which we put in a binding post, and set it with a screw. Thus we get a double connection where we cannot have a solid connection. There is no hanger board that I have seen and no method of hanging lamps by hook or connecting than by a single connection to the hanger board that will not develop trouble in ordinary practice, but by using the double connection you get very good protection. I have mentioned in the paper that it is our practice to charge the customer for arc light installations. I am aware that this practice does not generally obtain throughout the country. One of my employés, who came to me from an older company, once told me that I was wrong in attempting this; that the thing could not be carried out; that it would make trouble and give us bother in endeavoring to collect from or compel customers to pay for arc light installations. I maintain that there is no more reason why we should do wiring free than there would be for a gas man to charge nothing for piping a house. There is no more reason why a gas man should pipe a customer's house, than there is for our wiring a house for incandescent lamps. Of course in the early day, when arc lights were still an experiment, we were anxious to get the thing in a man's house so that he would try it, hoping that if he liked it he would keep it, and so we did not charge for wiring. And later on the same thing prevailed, and to get a customer started we were willing to do the wiring for the sake of getting him converted from the present method of lighting by gas to the new method by electricity. And so that practice has been followed up because the precedent had been established. But there is no sense in it—no matter how much you think you cannot get away from it. It is like anything else. If you charge for the wiring there is likely to be an awful kick at first, but it will soon wear away, and men will finally come to recognize it as a correct business principle—that you have got to make from some other source the money which you spend in putting in lamps, and that if you are making a fair rate of profit on your lamps, if you have still to add this extra cost of wiring to it, you increase the cost, and if you place this increased cost of the lamp on the man who keeps the light for but a few months, then you are imposing on the man who keeps his light for a long time. We have effected a saving or decreased our expenses more than $600 per month by refusing to put in the lamps free. We make a charge of 35 cents per hour for all labor except that of the foreman, and we charge 40 cents per hour for his time. We also chargs for the horse and wagon at the same rate, and we charge from the time the men leave the station until they return. That charge will usually cover the time of connecting it in circuit, and the cost of the minor things which we never take out—in the way of screws, insulators, and other such little things—and perhaps also the cost of removing the wires. We have another shrinkage there in the scrap wire which comes in, and which may or may not be covered. But in a measure this charge covers largely the expense. We make a point with our customer that we want to own those appliances, that we bear the cost of them, but that we want to charge him for the labor, and we charge for the labor in that way. We do not pay those prices, as you understand, to our linemen. We own our own teams. The horse and wagon is worth $4 a day to us, charging at that rate, and do not cost us anything. I know that there is a good deal of objection made to this plan, and in fact the president of our company said that I was taking a wrong stand, but it did not make any difference to us, and after the first few months all objections were gone. Many of our customers require only short service lamps, as from October to the 1st of January, or perhaps through the winter, taking them out in the spring, and we have customers who take lamps for six months in the year only, their business being of such a nature that they do not require them longer. These people want the lamps every year, but not for all the year, but still they do not want their wires taken out; and so to save increased expense to them, and to avoid the taking out and putting in of wires, we require them to sign a contract, when the period of service expires, for the succeeding season. Then we leave the wires in, and agree to connect them without cost. But for our own protection we disconnect them entirely from the circuit. We always cut the wires out of the building, close the circuit at the pole, and take down the loop leading to it. I am satisfied that it is well worth the cost to do this, for then we are in no danger of burning them up, and by cutting them off, closing up and making a solid circuit, we do not have to look for trouble from cut-out boxes or other bad contacts, nor do we have trouble. The place where men never think to look for trouble is in these dead wires. They forget them. While this costs a little money, I think it saves a little in the end.

Mr. NICHOLLS: I am very glad that Mr. Ayer dwelt so strongly upon the inadvisability of central station companies doing free wiring. Of course I am not at the present time interested in arc lighting, but when we commenced incandescent lighting we were advised to do free wiring. I took the ground that it would be unbusiness like; that it would be on the principle of those people who sell tea at so much a pound and give a chromo with it. I took the ground that we would not develop as rapidly if we did that, as we have, fortunately, done. We have done our own wiring, for the reason that in our city we have not had the advantage of first class construction companies upon whose work we could depend. There was some little wiring done and it was unsatisfactory, and we started in to do it ourselves as a measure of self protection. We have connected up — I do not remember the total number — but in the last 15 months we have wired for upward of 12,000 lights, and we have endeavored to make it as near cost as possible, so as not to make it burdensome to the consumer. Still, I find that we have made a very fair percentage of profit, which has gone to defray the many items of expense that would otherwise be chargeable to general expense account. I think if there could be some understanding that free wiring should not be done it would help

the electrical industries, because when we started to charge we were met with the statement that this town and that town were doing free wiring, and we ought to do it the same way. It is simply a matter of business. If we do not charge for wiring we are going to get it out of them in some other way. If we are going to lose ten, fifteen, twenty thousand dollars a year for wire we have got to make it up in our meter charges or in some other way.

Mr. Francisco: There is one feature of this business that has been overlooked. It is very convenient to carry out Mr. Nicholls' plan, and I fully concur in his views—provided there is only one company in the place. But if you have got two or three different companies, an entirely different plan of operations is inaugurated at once. If you charge for wiring, the other company, nine times out of ten, will put the charge for wiring at less, or the people will go to one company and get their price and then to another company and get their price and so on and the man who does it for the least money gets the job everytime. Of course the true way is to charge for wiring, but with competition and two companies I have found it is utterly impossible to charge for wiring because the other companies would do it for nothing, and of course you cannot get parties to take your lights when they can get the same thing without paying for it. In regard to Mr. Ayer's paper, I have been very much interested in his remarks. They have been very instructive to me, because I had the pleasure of examining Mr. Ayer's station all through. The good book says you should not envy, but it seemed to me I could not help feeling very peculiar in going through that station. It is complete in every respect, and there are a great many things there that are instructive, and every electric light man should have the chance to examine, if he could, and adopt them, because they are practical and based on practical working. Now I hope that we can in time adopt some plan or some arrangement in regard to this very question of free wiring, because it is a very serious difficulty; there is no question about that. In many stations renewals are furnished free. I furnished them myself. I made nothing for renewals on lamps. Of course it is of dead loss to the company, and the charge should be made for renewals the same as is made for wiring and those things, and I trust that in time we may be able to get some basis or plan of operation whereby we can carry this out and have our return for that service just the same as we do for all other service.

Mr. Nicholls: I am glad Mr. Francisco referred to the question of competition. I think it is better to sell your product at a lower price—to give a discount rather than to give something for nothing. You then know exactly what you are doing and exactly what you can afford to do. If you do free wiring I maintain that you have no right to charge it up to capital account. You ought to charge it to expense account. When once you wire a customer's premises he has you at his mercy. He can tell you to take your wires out. Whereas, if you meet competition by saying we will give you ten, fifteen or twenty per cent. discount, then if you have a row with your customer you simply lose his custom, but you are at no financial loss in the matter as regards the actual expenditure of capital, and I think that is a far more reasonable way of meeting competition—to sell the product at a lower price.

Mr. Francisco: I would say that I always charge free wiring to expense and not to construction or anything else. It is a dead loss.

Mr. Seely: Three of the largest companies in New York City started in to do free wiring. I think they spent half a million dollars before they realized the fact that it was an expensive luxury. It cost them on an average about $3 a light to put in. They finally reached a combination whereby they agreed to charge the customer actual cost. Some enterprising gentlemen put the actual cost down to $1.50 a light. His opponent kept his price stiff at $3.00. The $3 man did not get the business. Finally the wiring got down again to about $1 a light. But I do not agree with the gentleman about the account to which wiring should be charged. In some large buildings there is $10,000 worth of wiring alone. If you make a contract with a man to wire a building, you make a contract with him to either buy that wire at the expiration of your contract or to remove it. You will find that the companies have spent thousands of dollars in wiring large buildings, and it would be nonsense to charge that to expense. I would like to ask Mr. Ayer a point in relation to the adjustment of the arc lamp. It appears that Mr. Ayer adjusts the ammeter up to the arc lamp. In other words, he establishes a zero point and adjusts his lamp to that zero point. It may be 5, 10 or 15 ampères. It may be one ampère. I do not believe that an arc lamp can be accurately adjusted, taking a large plant such as Mr. Ayer has. It is a pretty hard matter to get all those lamps nicely adjusted so that they take a certain amount of current. We have found in calibrating our meters—we have sent them to an institution of technology and calibrated them there and sent another to a first-class instrument maker and we would find they would vary. We would write to those gentlemen and they would say they had gone through the work carefully, probably in shipping it got out of adjustment. What electric light people at the present time suffer for is accurate instruments—something that will not get out of order.

Mr. Ayer: I would like to say to Mr. Seely about the inability to accurately adjust arc lamps in a large station, that I think we are more able to do it in a large station than in a small one. I have two young men that I do not think can be made competent to adjust an arc lamp until after two months practice—I don't think any one can. I have two young men I give that work to and they have become very expert at it. It is very remarkable how quickly they will detect a flaw in a lamp and locate the cause of it; and the same way about the carbons. It requires practice. In a large station we are better able to do that than it can be done anywhere else. But there is no question that you can get a better adjustment of a lamp by having a constant current maintained on the circuit and arriving at what the average length of arc shall be by the use of a voltmeter rather than by judging it by your eye. If the lamp is in proper condition you will find that it has nominal voltage. There is a range between the hissing and the flaming point which when adjusted by a voltmeter will bring the lamp where it belongs. But you will frequently adjust a lamp by your eye or judge it by the flaming and hissing point, and find that it is either too low or high. You will find that when you have a lamp that is working defectively from some mechanical trouble—without the instrument you do not detect that. You do not know what the length of arc is, what the voltage consumed. It is the result of my experience in the matter. We have it under the best conditions where we handle a number of lamps a day—fifteen or twenty lamps going through our repair shops, being repaired and overhauled—that number of lamps passing through the hands of my own men every day, they have become, as I say, very expert, and they are accurate in arriving at results. By contrast, however, you might mention a manufacturing company. I know that when my lamps were sent to me the parent company stated that they were in good adjustment to hang up on the circuit. Unfortunately—or fortunately rather—I had been connected with a parent company prior to building that station, and as the lamps came in I had them taken out and cleaned up and then reassembled and tested, to see where the faults were, and adjust them. I found about 10 per cent. of them that would not burn at all if they had been hung up, and three and a half per cent. that would have opened the circuit, yet it was not apparent in the lamp But the young men whom they have had put them through a series of tests. Those lamps had all been, as they thought, adjusted. They went along and looked at them. The men who did that were earning a dollar or a dollar and a half a day. They never saw the lamps afterward, and know very little of them any way. Now, taking their experience of it, one would say that their method of adjusting would not amount to very much and the adjustment of arc lamps was not a very practical thing. But my experience is that it is a very practical thing, and can be arrived at very closely, but it takes time and you must take one or two of your station men and insist on their doing it. The way I have insisted on it is to have the lamp burn eight hours, compel them to go through that whole thing during the period of the consumption of the carbon. It costs a little money, but the money is saved in the end. It does not cost half as much to burn a lamp all day and supply it with carbons as to put that lamp into service and have the defects develop after it has been hung up. Take a double carbon lamp, it will burn all right. Try it on the other side, it will burn all right. In an hour it will go out. By this method of testing you will discover the cause of that. I use boys in this work eighteen or nineteen years old. They are paid $35 or $40 a month for that character of work. I keep sifting them through. Ultimately I think I am going to have some bright boys. It is just like making rules and having systems. If you make a rule you want to enforce it. They used to think lamp adjustment was fun, but I insisted on their working around, applying the voltmeter and the ammeter. That is a point on which I think there is no danger of laying too much stress.

Mr. Orford: I have been operating arc lamps for seven or eight years, and I have had various types of arc machines, and I know there are some of them, as Mr. Smith said the other day, on which the only governor is a big load. I think it is a very crude way of running a station to trust to the machine without a governor. It is really going to the same practice as taking the governor out of the engine. Nobody would dream of setting up a locomotive or stationary engine without setting up a good governor, and in a great many instances the highest price will be obtained for an engine having a good regulating governor, and the same thing can undoubtedly be done with the arc machine. I suppose the fact that people do not look out for the best governor is evidence that they are satisfied with what they have. I am not saying this for the purpose of advertising any person's dynamo. I have been accused of doing that at times. But it is because I am somewhat peculiar on that point. I know there are dynamos in existence to-day and if you take one light it will show it is running 10 ampères. Take the Weston. You put 40 lights on that machine, it will show 10 ampères. I know the regulation devices have to be carefully looked to, but when once placed in position they give no trouble. That is my experience in seven years. The same thing can be said of an arc lamp. An arc lamp, to my mind, requires only one adjustment. I have arc lamps in operation in stores for six years and they have never been touched. The only thing they have had done to them has been the trimming. You bring those lamps into the station and if those lamps do not burn as well as the average lamp I will take a back seat. I think I can say that I have had the credit—without being egotistical—of having as good lamps as can be shown anywhere. I certainly know that an arc lamp can be constructed, and having once adjusted it for whatever current you intend maintaining, your arc lamp will burn correctly if you maintain that current. With reference to this opposition, which is constantly cropping up, when we started into the incandescent business we thought the wisest thing would be to go to the customers, get as good a price as we could, and ask them for as small an amount to begin with as possible. Their gas fixtures were all in the stores. We had to say something to them to get them to adopt the electric light in preference to gas, and we thought it would not be a very good method to begin by telling them that they had to pay for the wire. Consequently we took the ground that the smaller the expense to the customer in the first instance the more customers we would be likely to get. We recognized the fact that we were going to spend a considerable amount of money in wiring stores, and we thought it would be a permanent business. We have had the incandescent lights in stores for four years. We have had very good prices. The cost of the installation is a small amount when you spread it over four, or perhaps forty, years. I see no deterioration of the material and the amount of money necessary to keep it in good condition is very small indeed. The question of renewals is one about which we have debated very considerably. The only advantage which I see in the customer buying his lamps would be that we could sell them in a bunch and have done with it, whereas we supply them one or two at a time as required. The disadvantage of the customer buying his lamps has appeared to us to be that some of them might burn the lamps as long as they would burn, and in that way it would not be very creditable to us, as we have to compete with very good gas. Now, then, if the convention can help us in any way to kill competition in our town, we would like to get some assistance. The competition which has been threatened us has been threatened by a member of the association, and if the association can do anything to keep a member from coming into competition with another member of the association, we should be glad of its assistance.

Mr Scott: I feel very grateful to Mr. Ayer for his talk. It is just the kind of talk I came here to listen to. We do not have arc lights, but we have incandescent lights. I gather a vast amount of valuable information from what he says, and I understand well the importance which he attaches to standardizing a voltmeter and an ammeter by an instrument not made by the parent company. We have a standardized voltmeter and ammeter made by the parent company, and the voltmeters and ammeters on the switchboard are apparently all right according to that; but in testing otherwise, I found that one street loop having an ampèrage of about 7 7-10, running on the series system, showed, when I put it onto one machine by itself, 8 ampères by that ammeter; on another machine 10 ampères by that ammeter, and on another machine 11 ampères by that ammeter. I transferred the ammeter to the other machine, and I found the trouble was in the instrument itself. In testing the exciters of the direct current machine, I found one was given 98 volts, another 115, another 140. There is evidently something wrong about that, and I did that only by getting a Weston voltmeter, and putting on in the place of the voltmeters which we have in the station. I think it is of a great deal of importance to everybody. Our men are told to test and standardize the voltmeter and ampère meter every hour. In regard to free wiring we have stopped that. We did it because the gas company, which had lowered its rates from $2 to $1.60 in order to compete with us, finding that that was not sufficient, had offered to pipe all large stores and residences free. With small stores they threw in fixtures. We immediately started free wiring. We told people that the gas company knew they had an inferior article or they would not have done that, because since 1856 every man had had to pay for every foot of pipe from his meter to his burner. The increase of consumption of electric light has not varied a particle since they began with free piping and we began charging for wiring, and I think that while sometimes it may be a loss of capital for a few months in the end it is good business management. But when you have a good article and are determined to keep it good and another man is trying to cut your throat, it is poor policy to spend your capital in trying to cut his throat. I would rather stand aside and try to convince the public that I have a better article and cannot come down to any such rates as those. When we started we of course wired free in stores. We paid the cost of installation of 300 lamps in four blocks on one of the principal streets, which was $696. That was two and a half years ago. Those lamps have paid us $300 a month during that time. I believe that would be a good investment. At the end of the year we charged that off to profit and loss. But after firmly establishing the company I think that wiring should be charged for. It must become in future a rule to be adopted by the electric light companies, just as it used to be by the gas companies and just as it still is by the water companies. Of course if we are going to make a good lot of money out of some particular lamp we can put the wires in free and say nothing about it.

Dr. Louis Bell: With reference to what was said by

Mr. Orford in relation to the governor I have frequently heard the same remark casually made, and I must say that from that standpoint we ought to congratulate the makers of such apparatus from the bottom of our hearts, because I can assure the members of the association that no such result can be obtained by the best scientific instruments made and adjusted with the utmost care, kept in the laboratory, used only by skillful men. I leave it to you how likely it is that such results can be really attained in practice. Take the best laboratory instruments and they will get out of adjustment with the most skillful use, and when they are subjected to a degree of care which could not be even approximated in the most refined commercial work. I think the cause of the error that is so frequently made in ascribing exceedingly fine regulation to commercial apparatus is due to the fact that it is not sensitive enough to show more variation. I have tested first and last in the laboratory a good many commercial instruments. I find that a good many are excellent for rough work. But the needle of a sensitive ammeter will sway through several divisions, while the indicator on the commercial instrument will not move at all. I have seen a delicate ammeter put on an arc light circuit; and then the regulator of the machine was fiddled with and see-sawed with until it ought to have changed the current by a number of per cent. As a matter of fact the commercial meter showed small changes, the accurate instrument big changes. And even those accurate instruments have to be standardized very frequently to get good results from them. There are to-day no ammeters and voltmeters suitable for portable use that can go without watching. There are very excellent ones, fine instruments, but they want to be looked after. I am very much reminded in speaking of the commercial regulator that keeps absolutely X ampères flow over the line all the time. Of the gentleman we all know whose watch has not lost one-tenth of a second in two years, and of the other gentleman who takes pride in the fact that his family clock still keeps excellent time, as he assures you after comparison with the sun, and yet had not been cleaned for twenty years—a most marvelous piece of mechanism. I think we are very much inclined to overlook small discrepancies sometimes when the general results seem in the rough to be all right.

Mr. ORFORD: Any one familiar with an arc light station knows that we do not use Thomson's reflecting galvanometer to take readings by. There is no use in using an ammeter which fluctuates backward and forward. We use a Weston dead beat. The simplest way that I know of to keep your ammeters and voltmeters in good order is to have a pair of them. If you have a pair of ampère meters and put one in the station for every evening so that you can take a test once a month, that ampère meter will stand you a dozen years. If it is not possible to make an ammeter that will stand such a test as that, our friend Mr. Weston's life is spent in vain, I should say. Every one knows the difficulty of keeping a voltmeter in circuit that is only required on the incandescent work. A voltmeter being in a circuit is quite unnecessary in my opinion for incandescent work. If you could get a Howe lamp regulator you would find that that regulator would answer your purpose. Of course, the action of the voltmeter is principally on the lamp that is burned with it. They supply an excellent lamp and you can recalibrate that lamp once a week if you desire. My experience has been for four years with them. I assume that the Howell indicator will get out a little, but it is a very small amount. But you can take your lamp, regulate it and calibrate it to suit yourself. You can do it once a night if you like. We find that once a week is quite ample. Of course our readings are taken from the mains that go up the street. We take our readings from the mains occasionally with one of Weston's voltmeters. With that method we are able to find out whether our station instruments are pretty nearly accurate. I do not wish to be understood as saying for a moment that there is no variation in our current. The governor will not move unless there is a change in the feed. It is the same with the regulation of the arc lamp. Any one familiar with the regulation of the arc machine will know that the current does not stand steady. It goes backward and forward, up and down. You can limit it by devices which they have supplied and keep it moving but a very small amount. The arc lamp is not such a sensitive instrument that it is going to go out because there is a variation of 10 per cent. even in your current. I think you can vary the current 10 per cent., and there is not a man in the room can tell the difference. I can give you an instance. I happen to be running a machine which is really a 65-light machine. I was competing with the Thomson-Houston. I gave them pretty good competition and I dropped the current. I had 75 lights on the machine. I dropped my current down and there was not a person who knew anything about it. In fact a couple of years afterward, one of the lamps which I had had in use happened to get into the hands of one of my former competitors and he got it on his regular ten ampère circuit and he was surprised at the action of the lamp and wondered why the lamp had changed so much since I had it. He was not aware that I was running eight ampères. My competitor was running ten. Consequently you see that the difference of a quarter of an ampère even in a lamp is of no moment.

The following paper was then distributed but, owing to lack of time, was not read:

DIFFERENT FORMS OF CARBONS USED IN ARC LIGHTING.

By E. P. Warner.

In the period just preceding the introduction of the arc electric lighting commercially, experimenters and inventors had brought forward numerous plans, ideas, and theories regarding the size, form and manner of using carbons, and in view of the fact that no reasonably cheap method of generating the electric current then existed, a surprising amount of attention was given to the subject, and the developments of the art shown by many publications form no small part of our history of arc lighting.

It is not my purpose to dwell at length upon the history of carbons generally, but rather to touch lightly on some of the more notable forms known at the time of which I am speaking, and then to pass on to a consideration of the utility and practical results obtained with the different forms of carbons in use at the present time, paying special attention to the matter of form and size as affecting the results.

The form of a cylinder or pencil, it is noteworthy, was that used by Sir Humphrey Davy, in his earliest experiments, and he even devised special holders or claims to retain the carbon pencils in all alignment and facilitate their adjustment with a view of maintaining a constant and steady light.

Archereau subsequently adopted the pencil form of carbon, and used it in his lamp, now so justly considered as the first practical arc lamp; it does not appear, however, that he turned his attention particularly to the matter of form.

Wright and others stand on record as experimenters with carbon discs brought edge to edge and made to rotate as they were consumed, and the combination of a disc placed on edge above a vertical pencil of carbon was also tried at this early date.

Wallace and Farmer made use of broad, flat plates of carbon, placed in a vertical plane, one above the other, the arc forming between the edges as they were drawn apart and shifting back and forth from one end of the plates to the other. Another inventor, at about this date, placed flat plates of carbon side by side with the arc forming at the upper edges of the plates and an intervening insulation of some refractory material, the arc forming at the upper edges of the plates and gradually consuming them.

Jablochkoff in 1876 introduced his well known electric candle, a form of arc lamp in which cylindrical carbons are employed placed in a vertical position and held separated by a thin filling of refractory insulated material.

Now when we look back at the work of these early inventors and consider what special object they had in mind in making their experiments, it is at once apparent that it was continuity of action, and it stands on record that they met with fair success so far as the feature is concerned, some of the lamps being capable of twenty hours' burning without attention.

In 1874 Mathias Day produced an arc lamp in which two cylindrical pencils were placed in the upper holders and two in the lower holders, the upper ones occupying a plane with the lower and directly over them. Here the avowed object of the invention was to secure long continued operation of the light without requiring attention, and it is certain that he accomplished it in a very creditable and ingenious manner.

Coming now to the time of the commercial birth of arc electric lighting, we find Jablochkoff in the lead closely followed by Brush and Weston, each making use of the cylindrical form of carbon pencil and turning their attention most assiduously to the feature of continuity of operation, the first move being an increase in length of the pencils. Carré, a French manufacturer, at this time, became prominent as a maker of carbons, and succeeded in producing pencils about 7 1-16 inch diameter, and 32 inches in length, and it was thought by the use of lamps of suitable length these long carbon pencils could be advantageously used when long-continued burning was a necessity, but owing to the difficulties encountered in the manufacture and also trouble in maintaining proper alignment for the carbons a length of 22 inches was soon settled upon as most practicable and convenient.

As the business increased and the demands became better understood, the inventors again essayed to solve the problem of continuity of action, but, in many cases such attempts were but returns to old forms and methods, and did not result in any practical advance.

Various forms of double carbon lamps were introduced, and, for a time, these were thought to be the only practical and commercially successful way out of the difficulty, but more recent developments have shown a far simpler and better way, and one, furthermore, that cannot fail to impress the practical electrical engineer. I refer to the simple expedient of using a carbon pencil of five-eighths inch diameter, 14 inches in length in an ordinary single carbon lamp. It is true that this is not new, and that carbon pencils of such size, or even greater, were tried long ago; nevertheless, the introduction of carbons of this size and form has a very great bearing on the commercial side of the situation; but before going into that matter I wish to say a few words regarding the lighting efficiency of five-eighth-inch carbons.

Having noticed that the question had been raised as to whether these carbons would give as much light for a given expenditure of electrical energy, as would those of one inch diameter, I tried the following experiments:

Two single lamps were connected in series in an arc circuit, one being supplied with five-eighth-inch carbons 14 inches in length, the other with one-half-inch carbons 12 inches in length; around each lamp was branched a volmeter indicating the voltage. The lamps were then adjusted until they had the same voltage, and as current was of necessity the same in each it was a safe conclusion that equal amounts of energy were being supplied. Photometric comparison of the two lights was then made at the horizontal and at many different angles above and below, with the result that no perceptible difference could be found in the power of the lights; during the tests the current was maintained as constant as practicable and care was taken to base the comparison on an average deduced from a large number of readings.

Now, while this matter of lighting efficiency is one that concerns the people operating electric plants, it does not interest them to the extent that other features upon which I have yet to touch may, as I happen to know that the management of lighting stations look long and lovingly on any plan that seems to give good promise of reducing running expenses. To begin with, there is the difference in first cost between a single and a double carbon lamp, and the difference in the expense for repairs and attendance, these items varying of course with the different lighting system. Still another important saving is in the cost of carbons, the cost for a given number of hours run being fully 30 per cent. greater with half-inch than with five-eighth-inch carbons. There is the further important saving in the breakage of globes which often is caused by the sudden shifting of the arc in the double carbon lamp. Twin carbons, consisting of two cylindrical pencils placed parallel and in close juxtaposition to each other, and connected by a web throughout their entire length, have of late been introduced, and when in use the arc alternates between the different pencils comprising the upper and lower twin carbons. A test of these carbons, made principally with a view of determining the life and lighting quality, gave unsatisfactory results in the following particulars: It was observed that the duration of a burning for a given weight of material was not near equal to that which could be obtained with the same amount of material in a single cylindrical pencil. This I attribute to the more rapid disintegration of the turn carbon resulting from the very frequent heating and cooling of each member; indeed, this is found to be true of two carbons where arranged as in the Day lamp, or so that the arc alternates frequently between the different sets, and there is quite a noticeable difference in consumption of carbon for a given duration of lighting as compared with an ordinary single carbon of the same diameter burning without interruption.

Another undesirable feature of twin carbons is the shadow cast by the non-burning members, which while it may not be disagreeably noticeable when the lamp is provided with an open globe most certainly operates to reduce the total output of light.

It may be argued that the main item of expense in the manufacture of carbons does not lie in the material, and the fact that five-eight-inch carbon cost so little more than one-half-inch would bear out such a position, and I have merely mentioned the fact of the rapid disintegration and burning away of the turn carbons by way of explanation.

On motion of Mr. Francisco, amended by Judge Armstrong, it was resolved that the rules for safe wiring adopted by the convention be at once printed and a copy sent to each central station and insurance association in the United States.

On motion of Mr. Francisco, Sir William Dawson, Frank R. Redpath and Prof. Henry T. Bovey were elected honorary members of the National Electric Light Association on the recommendation of the Executive Committee.

On motion of Mr. Seely and by recommendation of the Executive Committee Mr. Thomas D. Lockwood was also elected an honorary member.

The convention then went into executive session.

REPORT OF THE EXECUTIVE SESSION.

The secretary presented the following report:

The condition of the association, so far as its membership goes, is much stronger and more encouraging than it was at the opening of the year. Many individual memberships have been dropped since the adoption of the present constitution, owing to the fact that memberships are, under it, very largely represented by corporations and firms instead of individuals. Notwithstanding this fact a quite large addition has been made, new members since the last report of your secretary, and the general interest in the affairs and work of the association have very largely increased, owing to the active agitation concerning the very important benefits arising from a membership and the representative character of the society.

According to the last secretary's report, the number of members who had paid dues for 1891 was as follows: Active members, 65; associate members, 107; total, 172. The present membership stands as follows: Active members, 78; associate members, 142; total, 220.

I beg to say, in connection with the total membership of this association, that it is far from what it should be, and far from what it might possibly be made, in view of the immense possibilities for the diffusion of valuable information within its grasp. Our active membership list, especially, should be very largely increased, and could be by making an active membership a valuable consideration and worth more than the annual dues amount to, in the way of practical information furnished during the year. I would suggest that the Committee on Data be increased in its membership; and that the collection and distribution among our members of important facts, figures and details relating to the furnishing of light, heat and power, be carried out systematically, persistently throughout the year. There is a vast field here for good and I consider it as important a work as the association has to do.

On motion the report was received and filed. The treasurer's report was then presented by Mr. Beane as follows:

This report is made from April 1, dating from the beginning of office until July 1st, our fiscal year dating from January to July and July to January of each year. This report is based on the books of the association and on the trial balance of the auditor on April 17 and on my trial balance of July 1.

The operations of the treasurer show the total receipts as $1,235. Total disbursements amount to $1,287.62, making the disbursements $122.62 over the receipts for that period. The proof of this is contained in the following: Balance in the bank April 17, indicated by the auditor's trial balance, was $1,373.15; balance in bank July 1, indicated by trial balance, $1,122.02; cash on hand July 1, $128.51; total of cash on hand July 1, $1,250.53, which total is $122.62 less than the amount on hand April 17, proving the difference between the receipts and disbursements as indicated by the report.

The assets of the association on July 1 consisted of cash in bank $1,122.02, and the value of furniture account charged with $214.15. The assets were further increased by the payment of the Committee on Exhibits of moneys disbursed.

The report was on motion of Mr. Seely referred to the Finance Committee.

Dr. Mason offered the following resolutions, which were unanimously adopted by a rising vote.

The National Electric Light Association, assembled in Montreal, at the close of its session desires to put upon record its appreciation of the distinguished honor shown it by the Dominion of Canada in the presence of His Excellency, Lord Stanley of Preston, Governor-General of the Dominion;

Of the large hearted hospitality of the city of Montreal, evidenced by many graceful acts, official and individual;

Of the tireless industry of the Citizens' Executive Committee, whose efforts have carried to completion the most successful meeting in the history of this body;

Of the grand work done by the Committee on Exhibits, shown in an exhibition of rare educational value, calculated to develop a larger appreciation of the flexibility of electricity, and its wide adaptation to human needs.

Of the gracious liberality of McGill College, which has lent the great dignity of its name and the personal influence and labor of its officials to the success of our meetings:

To the press of this city, whose extensive and fair reports of our meetings have extended our influence:

To the railway companies for their liberal reduction in fares, and to the Windsor Hotel management, where as guests we have found a home.

Resolved, That the above minutes be placed on the records of the association and a certified copy thereof be sent to the various bodies mentioned.

On motion of Mr. Seely, seconded by Judge Armstrong, the following resolution was adopted:

Resolved, That a vote of thanks be tendered to Mr. J. I. Gulick for the efficient and successful management of the exhibition now being held under the auspices of this Association, the largest ever held on this continent.

And that the secretary be directed to have this resolution engrossed and presented to Mr. Gulick.

On motion of Mr. Seely, seconded by Dr. Mason, a vote of thanks was extended to Mr. Luther Stieringer.

Mr. Frederic Nicholls, Mr. M. D. Law and Mr. A. M. Young were elected as members of the Executive Committee of the third class.

Dr. Mason gave notice of an amendment to the constitution—to the effect that in the first article the word "International" be substituted for the word National, so that the title of the association would be "The International Electric Light Association."

Buffalo was selected as the place for holding the February meeting of the association.

On motion of Mr. Seely a vote of thanks was extended to Mr. Allan R. Foote for his services, and the convention then adjourned.

Attendance at the Convention.

NEW YORK.

Miss Estelle J. Barney.
Mrs. C. H. Barney.
Mrs. E. Bartlett.
Mrs. W. H. Beardsley.
Miss Harriet Billings.
Mrs. W. L. Candee.
Mrs. Alexander Chenowith.
Miss E. Clark.
Miss L. Haywood.
Mrs. W. T. Hunt.
Mrs. W. J. Johnston.
Mrs. E. W. Little.
Mrs. H. Lufkin.
Mrs. Geo. T. Manson.
Mrs. W. J. Morrison.
Mrs. A. H. Patterson.
Mrs. Frederick Pierce.
Mrs. Chas. W. Price.
Mrs. Jno. A. Seely.
Mrs. T. J. Smith.
Mrs. Clarence E. Stump.
Mrs. H. M. Swetland.
Mrs. Benj. R. Western.
Mrs. Schuyler S. Wheeler.

BOSTON, MASS.

Mrs. G. L. Austin.
Mrs. F. E. Barker.
Mrs. C. E. Bibber.
Mrs. M. W. Brown.
Mrs. W. W. Castle.
Mrs. H. B. Cram.
Miss Donohoe.
Mrs. H. M. French.
Mrs. J. V. Hale, Malden.
Mrs. A. F. Mason.
Mrs. Joseph Merrill.
Mrs. Otis K. Stuart.

CHICAGO, ILL.

Mrs. E. P. Bailey.
Mrs. S. B. Chase.
Mrs. George Cutter.

OTHER CITIES.

Mrs. Cyrus O. Baker, Jr., Newark.
Mrs. M. J. Francisco, Rutland.
Miss Evelyn Hamell, Phila.
Mrs. E. F. Peck, Brooklyn.
Mrs. A. M. Young, W'b'ry, Conn.
Mrs. W. H. Moore, Plainf'd, N. J.
Mrs. F. Nicholls, Toronto, Can.
Mrs. C. R. Huntley, Buffalo.
Miss E. W. Armstrong, Cam., N.J.
Mrs. H. L. Mann, Wash., D. C.
Mrs. J. W. Marsh, Pittsb'rgh, Pa.
Miss M. Middleditch, Brooklyn.
Mrs. J. K. Smith, Waterb'y, Conn.
Mrs. J. D. McIntyre, Syracuse.
Miss W. A. Lynch, Canton, O.
Mrs. C. Lee Abell, Buffalo.
Mrs. C. T. Richmond, Frem't, O.
Mrs. F. L. Dallen, Brooklyn.
Mrs. B. F. Hamilton.
Mrs. James Pass, Syracuse.
Mrs. F. H. Leonard, Syracuse.
Mrs. J. M. Orford, Bridgeport.
Miss Emily Smith, Wash., D. C.
Miss Mildred Abell, Buffalo.
Mrs. Eugene F. Phillips, Prov.
Mrs. G. Hutchinson, New Haven.
Mrs. F. C. Mason, Brooklyn.
Mrs. A. B. McDonald.
Mrs. W. H. Moore, Plainfield.
Mrs. H. M. Daggett, North Attleboro, Mass.
Mrs. S. G. Stiness, Pawtucket.
Mrs. H. H. Fairbanks, Worcester
Miss Slinn, Montreal.
Miss Fletcher, Montreal.
Miss Crowley, Montreal.
Mrs. Geo. B. Redman, Rochester.
Mrs. Edward A. Maher, Albany.
Mrs. G. S. Bontwell, Worcester.
Mrs. C. D. Warner, New Haven.
Miss E. Johnson, Greenw'h, Conn.
Miss Lilian Johnson. " "

GENTLEMEN.

NEW YORK.

Ackerman, P. C., man. N. Y. office Am. Electrical Works.
Adams, M. F., Edison General Electric Co.
Aidall, John E., Brush Electric Co.
Alexander, P. H., Alexander, Barney & Chapin.
Babcock, W. R., So. Pass. Agent, Central Vt.
Barbarie, E. T., N. Y. Insulated Wire Co.
Barney, Gen. C. H., manager Electrical Exhibition.
Bartlett, E. E., engraver.
Bell, Dr. Louis, editor THE ELECTRICAL WORLD.
Beane, John W., secretary and treas. Nat. Elec. Light Asso.
Beardsley, W. H., Receiver Empire City Electric Co.
Bowman, Fred A., Thomson-Houston Electric Co.
Burdick, J. R., H. W. Johns Co.
Caldwell, Edward, associate editor THE ELECTRICAL WORLD.
Candee, Captain Willard L., manager Int. Okonite Co.
Cavell, E. V., *Street Railway News.*
Coles, S. L., editor *Electrical Review.*
Colvin, F. R., bus. mgr. *The Electrical Engineer.*
Corey, R. B., manager Electrical Supply & C. Co.
Castle, Wm. W., P. & B. Conduit and Construction Co.
Chase, S. A., Western Electric Co.
Cheever, H. Durant, International Okonite Co.
Chenowith, A. C., Monolithic Conduit and S. Co.
Churchill, W. H., Edison General Electric Co.
Crane, W. F. D., Engineering Equipment Co.
Cullen, W. F., E. P. Gleason Mfg. Co.
Davis, A. E., *Electric Power.*
Davis, C. J., stenographer.
Dillont, Col. J. Frank, THE ELECTRICAL WORLD.
Dunham, S. E.
DeRonde, Frank S., Standard Paint Co.
Dreyfuss, T. G.
Ferguson, C. G., N. Y. City Press Association.
Field, C. J., Field Engineering Co.
Foster, H. A., Sp. Agent N. Y. State Electrical Census.
Godfrey, J. W., New York Insulated Wire Co.
Gordon, W. H., W. H. Gordon & Co.
Green, S. D., Edison General Electric Co.
Gulick, J. D., Electrical Exhibition.
Guy, Geo. H., N. Y. editor of *Electricity.*
Hamilton, B. F., Sawyer-Man Electric Co.
Hammer, W. J., electrical expert.
Hart, L. H., THE ELECTRICAL WORLD.
Harrington, F. W., Tropical American Telephone Co.
Hunt, W. T., *Electrical Age.*
Hunter, R. J., Patterson, Gottfried & Hunter.
Insull, Samuel, Edison General Electric Co.
Issertel, H. G., Alexander, Barney & Chapin.
Johnston, W. J., publisher THE ELECTRICAL WORLD.
Johnston, Albert E., J. H. Johnston & Company.
Jones, A. I., Edison Electric Illuminating Co.
Keefer, E. D., Western Electric Co.
Kelly, J. F., Edison General Electric Co.
Kimball, R. J.
LaRue, Geo. W., Crocker-Wheeler Electric Motor Co.
Leonard, H. Ward, president H. Ward Leonard Co.
Lewis, Eugene N., counsel Edison General Electric Co.
Little, E. W., general manager Interior Conduit & Insulation Co.
Lufkin, H. L., manager C. & C. Electric Motor Co.
Manson, George T., International Okonite Co.
Martin, T. C., editor *The Electrical Engineer.*
McLaughlin, W. R.
McQuaide, Jas. P., treasurer National Conduit Mfg. Co.
Miller, Henry J.
Mills, H. H., American Electric Light Co.
Muir, John, Edison General Electric Co.
Myerson, E., stenographer.
Noll, Augustus, New York Insulated Wire Co.
Oscanyan, Paul, electrician Interior Conduit & Insulation Co.
Outcault, R. F., artist THE ELECTRICAL WORLD.
Paine, C. McL., *Electricity.*
Patterson, A. H., Phœnix Glass Co.
Peck, E. H., Phœnix Glass Co.
Pearce, Frederick, Pearce & Jones.
Phelps, G. M., president *The Electrical Engineer.*
Pierrez, J. C., Goodrich Hard Rubber Co.
Price, C. W., *Electrical Review.*
Richards, H. T., *Electrical Review.*
Rosenstamm, S., Lewisohn Bros.
Ryan, R. W., official stenographer.
Schieren, C. A., Jr., C. A. Schieren & Co.
Seely, John A., manager Complete Electric Construction Co.
Seller, H. W., Seller Water Tube Boiler.
Shain, Chas. D., Edison General Electric Co.
Shainwald, Ralph L., President Standard Paint Co.
Sheehy, R. J.
Shippy, H. L., Jno. A. Roebling's Sons' Co.
Smith, H. J., Edison Elec. Ill. Co.
Smith, T. J., The E. S. Greeley & Co.
Steinberger, Jos., Fibrone Co.
Stephen, E. W.
Stieringer, Luther, electrical engineer.
Stump, C. E., manager *Street Railway Journal.*
Sullivan, M. C., Am. Institute Electrical Eng.
Sullivan, M. J., Edison General Electric Co.
Swetland, H. M., president *Power-Steam.*
Taltavall, T. R., editor *Electrical Age.*
Taltavall, J. B., *Electrical Age.*
Taylor, S. F., Patterson, Gottfried & Hunter.
Vance, A. S., general superintendent H. Ward Leonard & Co.
Vander Weyde, P. H.
Voorhees, F. Day, gen. sales agent Norwich Insul. Wire Co.
Walsh, Louis, Thompson & Robertson.
Walsh, C. C.
Western, Benj. R., Manufacturers' Advertising Bureau.
Wetmore, Jean A., Int. Okonite Co.
Wetzler, Joseph, editor *The Electrical Engineer.*
Wheeler, Schuyler S., Crocker-Wheeler Electric Motor Co.
Wiman, Erastus, pres. Port Richmond L., H. and Power Co.
Wiley, G. L., Standard Underground Cable Co.
Wilhemi, E. A., Fayerweather & Ladew.
Wood, E. E., Eastern manager *Electrical Industries.*
Master Franklin A. Johnston, New York.
Master Percy R. Western, New York.
Master Albert H. Smith, New York.
Master Alexander Chenowith.

BOSTON, MASS.

Austin, Dr. G. L., *Practical Electricity.*
Barker, F. E., State Gas and Electric Commissioner.
Belknap, Chauncey, Thomson-Houston Int. Electric Co.
Bibber, C. E., Consolidated Electric Mfg. Co.
Bigelow, C. H., Whitmore & Robinson.
Bottomley, H., Germania Electric Co.
Brophy, Capt. Wm., Electric Mutual Insurance Co.
Brown, M. W., Eastern Elec. Sup. Co.
Burghardt, G. H., Page Belting Co.
Clark, A. T., Am. Circular Loom Co.
Craig, J. H., Holtzer-Cabot Electric Co.
Cram, H. B., treasurer Bernstein Electric Co.
Crosby, E. H., *Boston Post.*
Currier, C. W., Page Belting Co.
Davenport, G. W., Thomson-Houston Int. Electric Co.
Donohoe, F. E., Sawyer-Man Electric Co.
Dowse, W. F., New York Insulated Wire Co.
Kirkland, J., Thomson-Houston International Co.
Field, A. B., Supply Dept. Thomson-Houston Electric Co.
Griffin, Captain Eugene, Thomson-Houston Electric Co.
French, H. M.
Hamblett, G. H., manager C. A. Schieren & Co.
Kellogg, Chas. P. F., rep. A. E. Croll.
Lean, G. R., Bernstein Electric Co.
Lockwood, Thomas D., American Bell Telephone Co.
Mason, A. F., general manager Simplex Electric Company.
Magee, F. A., manager Engineering Equipment Co.
Merrill, Joseph E., The American News Co.
Price, C. B., Pettingell-Andrews Co.
Ryckman, J. W.
Shaw, A. C., *The Electrical Engineer.*
Stuart, Otis K., Germania Electric Co.
Vose, Ralph, Mass. Elect. Engineering Co.
Waterman, John B., Thomson-Houston Int. Electric Co.
Wilson, J. S., *Electrical Enterprise.*
Woodman, W. C., Standard Electric Supply Co.

CHICAGO.

Bailey, Geo. C., Western man, John A. Roebling's Sons' Co.
Bailey, E. P.
Baker, John S., *Western Electrician.*
Beggs, John I., district man., Edison General Electrical Co.
Crandall, C. D., manager Western Electric Co.
Cutter, Geo., electrical specialties.
Dean, D. B., Electric Merchandise Co.
De Land, Fred, THE ELECTRICAL WORLD.
Dickerson, J. W., editor *Electricity.*
Hornsby, J. A., sec'y Elec. Dept. World's Exposition.
Kreidler, W. A., publisher *Western Electrician.*
Meeker, Geo. H., Western manager N. Y. Ins. Wire Co.
Monroe, P. G., *Stationary Engineer.*
O'Hara, J. B., editor *Western Electrician.*
Pearson, W. B., Ball & Wood Co.
Smiley, Hugh, Globe Electric Cordage Works.
Taylor, William, asst. manager The Electrical Supply Co.
Washington, Irving, bus. manager *Electricity.*
Watters, W. R., *Whipple's Reports.*
Weir, F. W., manager Falls Rivet and Machine Co.
Wilmerding, C. H., manager Chicago Arc Light and P. Co.
Willcox, W. R. B., Electric Merchandise Co.
Winston, H. S., Illinois Electric Material Co.

ALBANY, N. Y.

Frey, Charles P., chief electrician Greeley Laboratory.
Maher, Hon. Edward, gen. mgr. Albany Elect. Ill. Co.

ALLEGHENY, PA.

Hunter, J. D., City Lighting station.

AUGUSTA, GA.

Platt, J. B., general manager Augusta Exposition.

BALTIMORE, MD.

Greensfelder, L. S., Ries Electric Specialty Co.
Ries, Elias E. Ries, Electric Specialty Co.
Tudor, H. C., Brush Electric Co.

BAY SHORE, L. I.

Watson, Wm. B.

BRANTFORD, ONT.

English, E. L., Waterous Engine Works Co.

BRIDGEPORT, CONN.

Bryant, W. C., manager Bryant Electric Company.
Orford, J. M., president Union Electric Manufacturing Co.
Stanley, H. D., Bridgeport Brass and Copper Co.

BRIDGTON, N. J.

Smith, Fred F., secretary Ferracute Machine Co.

BRISTOL, PA.

Scott, Chas. E., Bristol Electric Light and Power Co.

BROOKLYN, N. Y.

Chinnock, F. R., Edison General Electric Co.
Ferguson, Jas., superintendent Municipal Electric Light Co.
Dallen, F. L., City of Brooklyn Lighting Department.
Mason, F. C., Gamewell Fire Alarm Telegraph.
Middleditch, Rev. Robert Henry.
Peck, E. F., gen. supt., Citizens' Electric Illuminating Co.
Ford, A. W., Brooklyn Electric Light Co.
Haviland, J. M., Brooklyn Electric Light Co.
Naughton, J. W., Brooklyn Electric Light Co.
Miller, J. C.

BUFFALO, N. Y.

Abell, C. Lee, manager Thomson-Houston Electric Light Co.
Abell, Master Harold L.
Boulton, W. H., Aluminium Carbon Co.
Doty, Fred V., Aluminium Carbon Co.
Huntley, C. R., sec. Buffalo Electric Light and Power Co.
O'Day, Charles, Jr., Buffalo Electric Light and Power Co.

CAMDEN, N. J.

Armstrong, E. A., prest. Camden Lighting and Heating Co.
Burleigh, J. J., gen. man. Camden Lighting and Heating Co.

CANTON, O.

Lynch, W. A., general manager Canton Electric L. and P. Co.

CINCINNATI, O.

La Boiteaux, F. M., La Boiteaux Elect. Motor and Fan Co.

CLEVELAND, O.

Crouse, J. B., Standard Carbon Co.
Miles, Benjamin F., National Carbon Co.
Rodman, C. L., manager Globe Carbon Company.
Smith, W. D., National Carbon Co.

CUYAHOGA FALLS, OHIO.

Babcock, E. L., pres. Falls Rivet and Machine Co.
Long, J. A., pres. Falls Rivet and Machine Co.

DALLAS, TEX.

Clower, J. M., Clower, Harris & Co.

DANBURY, CONN.

Wightman, E. T., supt. D. & B. Electric and Gas Light Co.

DENVER, COL.

Keith, D. M., Electric Light Fixtures.
Rollins, E. A., pres. Denver Cons. Electric Co.

ELIZABETH, N. J.

Ogden, S. R., Elizabeth Electric Light Company.

ELLSWORTH, ME.

Palmer, F. S., gen. man. Ellsworth Illuminating Co.

FREMONT, O.

Richmond, C. T., pres. Thomson-Houston Carbon Co.
Urquhart, D. F., Thomson-Houston Carbon Co.

FORT WAYNE, IND.

Knight, C. S., Fort Wayne Electric Co.

FITCHBURG, MASS.

Coggeshall, H. S., treas. Fitchburg Gas and Electric Co.

GENEVA, OHIO.

Cleveland, W. B., Forest City Electric Works.

GREAT BARRINGTON, MASS.

Russell, J. L.
Mignery, J. H., Great Barrington Electric Light Co.

HARTFORD, CONN.

Davis, Frederick W., sec'y Perkins Elect. G. Mfg. Co.
Hart, Gerald W., Hart & Hegeman Co.
Hatch, E. B., secretary Johns-Pratt Co.
Newton, C. E., manager Jewell Belting Co.
Tolles, C. L., Jewell Belting Co.

HOUGHTON, MICH.

Dee, James R., gen'l mgr. Peninsula Electric L. and P. Co.

KANSAS CITY, MO.

Weeks, E. R., manager K. C. Electric Light Co.

LA FAYETTE, IND.

MacMullan, R. H., manager Brush Electric Light Co.

MALDEN, MASS.

Clark, C. A., B. S. Hale & Co.

MANCHESTER, CONN.

Hills, C. L., Perkins Electric Lamp Co.

MILWAUKEE, WIS.

Coleman, S. G., Badger Electric Co.

MONTREAL, CAN.

Carroll, John.
Childs, Arthur E.
Christie, W. E.
Corbett, M. W., Edison General Electric Co.
Corriveau, A. J., Prest. C. E. C. & S. Co.
Horn, John
Ness, T. W.
Shaw, W. B. S., with T. W. Ness.
Wonham, Walter R.

MONTPELIER, VT.

Blackwell, E. D., treas. Standard Light & P. Mfg. Co.

NEWARK, N. J.

Baker, C. O., Jr., Cyrus O. Baker & Co.
Hayes, Henry, Elizabeth Schuyler Electric Co.
McIntire, C. H., C. McIntire & Co.

NEW BRITAIN, CONN.

Whitney, L. C., New Britain Electric Light Co.

NEW BRUNSWICK, N. J.

Wisner, Frank P., Consolidated Fruit Jar Co.

NEWBURGH, N. Y.

Odell, H. B., Newburgh Electric Light and Power Co.

NEW HAVEN, CONN.

Hutchinson, G. W., manager Standard Electric Time Co.
Warner, C. D., Standard Electric Time Co.

NORTH ATTLEBORO, MASS.

Daggett, H. M., treas. Steam and Electric Co.
Dillon, L. W., pres. Steam and Electric Co.
Guild, C. T., Steam and Electric Co.

NORTH EAST, PA.

Phillips, J. R., Eureka Tempered Copper Co.
Possons, N. S., Eureka Tempered Copper Co.

OGDENSBURGH, N. Y.

Findlay, J. H., manager Ogdensburgh Gas and Elec. Light Co.

OTTAWA, CAN.

Bradley, W. G., Ottawa Electric Light and Power Co.
Gisborne, F. N., Government Telegraph Service.

PAWTUCKET, R. I.

Stiness, S. G., supt. Pawtucket Gas and Electric Light Co.

PERU, IND.

Barker, Thomas, Glass and Carbon Co.
Burns, R. C., Peru Glass and Carbon Co.

PETERBOROUGH, CAN.

Taylor, J. W., Brooks' Carbon Co.

PHILADELPHIA.

Bournonville, A., Alfred F. Moore.
Braddell, Alfred E., insurance inspector.
Cleverly, H. A., Cleverly Electric Works.
Hermann, Oscar, Heisler Electric Light Co.
McDevitt, Wm., insurance inspector.
Mainwaring, A. H., Brush Electric Light Co.
Porter, George.
Smith, T. Carpenter, manager Keystone Electric L. & P. Co.
Vallee, G. A., Vallee Bros.
Willyoung, E. A., electrician J. W. Queen & Co.

PITTSBURGH, PA.

Blaxter, G. A., genl. mangr. Allegheny County Light Co.
Marsh, J. W., gen. man. Standard Underground Cable Co.
Stillwell, L. B., Westinghouse El. and Mfg. Co.
Young, E. P., Sewickly Electric Co.

PLAINFIELD, N. J.

Moore, W. H., Gas and El. Light and Pow. Co.

POUGHKEEPSIE, N. Y.

Caudee, John N., man. Poughkeepsie Electric L. and P. Co.

PROVIDENCE, R. I.

Davenport, W.
Phillips, Eugene F., American Electrical Works.
Phillips, E. Rowland, American Electrical Works.
Hathaway, W. A., American Electrical Works.
Whittier, R. H., Drake, Payson & Whittier.

QUINCY, ILL.

Faunce, A. B., Quincy Electric Light and Power Co.

RENFREW, ONTARIO.

Wright, A. A., supt. A. A. Wright & Co.
Wright, C. H.

ROCHESTER, N. Y.

Redman, Geo. A., mgr. Brush Electric Co.
Sanderlein, T.

ROME, MICH.

Reade, R. P.

RUTLAND, VT.

Carruthers, Jas., Marble City El. Lt. Co.
Francisco, M. J., pres. Rutland Electric Light Co.
Francisco, Master Don.
Francisco, I. H., sec. Rutland Electric Light Co.

SANDUSKY, O.

Partridge, James Partridge Carbon Co.

SCHENECTADY, N. Y.

Law, M. D., Edison General Electric Co.

SOMMERVILLE, MASS.

Dow, C. T., Sommerville Electric Light Co.

ST. JOHNS, N. B.

Knudson, A. A., Eastern Electric Co.
Christie, A. J., Toronto Construction and Supply Co.

ST. LOUIS, MO.

Ayer, Jas. L., gen. man. Municipal E. L. and P. Co.
Hazletine, C. W., president Hazletine Co.
Parker, G. W., Parker-Russell Electric Co.

SUMMIT, N. J.

Doying, W. C. E., Doying Bros.

SYRACUSE, N. Y.

Hawkins, F. M., Electric Engineering and Supply Co.
Hines, Jesse L., Electric Engineering and Supply Co.
Leonard, F. H., Jr., man. Electric Engineering and Supply Co.
Seymour, A. P., Pass & Seymour.
Ogle, George H., *Daily Courier*.

TAUNTON, MASS.

Donnelly, Wm. T., Universal Loom Co.

TORONTO, CANADA.

Barr, M. D., Edison General Electric Co.
Johnson, Phelps, Ball Electric Light Co.
Morrison, W. J., gen. agent Fort Wayne Electric Co.
Medbury, Charles F., Thomson-Houston International Co.
Nicholls, Frederic, man. Incandescent Electric Light Co.
Rosentengel, W. R., Edison General Electric Co.
Mortimer, J. B., *Canadian Electrical News*.
Nicholls, Master Harry.
Stannard, Geo. C.
Thornberry, H. S.

TRENTON, N. J.

Perrine, F. A. C., electrician John A. Roebling's Son's Co.

WALTHAM, MASS.

Hill, F. T. G., Waltham Gas and Electric Co.

WASHINGTON, D. C.

Dunn, George M.
Foote, Allen R., agent Census Bureau.
Mann, H. T.
Royce, Fred W., Royce & Marean.

WATERBURY, CONN.

Mills, A. H., Steele & Johnson.
Smith, J. K., Wataga Electric Light and Power Co.
Young, A. M., secretary Connecticut Electric Co.

WILMINGTON, DEL.

Tyson, F. C., Katavert Mfg. Co.
Stanhope, W. H., Hard Fibre Co.
Sweeten, F. D., Delaware Electric and Supply Co.

WINDSOR, CONN.

Baird, M. E., Eddy Electric Mfg. Co.
Newton, A. D., Eddy Electric Mfg. Co.

WOODHAVEN, L. I.

Munger, A. S.

WORCESTER, MASS.

Fairbanks, H. H., Worcester Electric Light Co.

The Entertainments.

At 2:30 P. M. on Tuesday the members visited Champ de Mars, and Col. A. A. Stevenson, chairman of the Fire Committee, and Chief Benoit were in attendance to receive the visitors.

Little time was wasted before the parade commenced. First came the engines, bright as burnished steel; then the ladders and the reels. After passing in view in single file they made a second tour two deep, and then again three deep. The visitors were shown the ladder drill, and could hardly believe that in such a marvelously short time the firemen could be in at a fifth-story window with their life-saving apparatus.

From half past four until half past six the beautiful grounds of Terrance Bank, the residence of Mrs. R. S. Redpath, were thronged with visitors, who passed a very pleasant hour in promenading, chatting and listening to sweet strains of music from a band of 15 pieces.

The conversazione at the McGill College was a grand success. A large tent was erected in the space between the college and Redpath Museum, in which were tastefully arranged tables holding an assortment of light edibles. A band of 25 pieces were stationed in one corner of the tent, where they played delightful music throughout the evening. By half past nine Molson's Hall was crowded with handsome ladies and gallant men, who promenaded from the hall through the tent into the museum. The committee who received the visitors were Sir Donald A. Smith, Mr. and Mrs. F. R. Redpath, ex-Mayor and Mme. Beaugrand, Prof. and Mrs. H. T. Bovey and Mr. J. W. Beane.

At 3:30 on Wednesday some 400 guests and members of the association were driven through the city and round the mountain, returning at 5 o'clock. Many partook of the hospitality extended to them by Mrs. John Molson. The beautiful grounds of Belmont Hall were thronged with visitors during the reception hours, which were from half-past 4 until half-past 6. The evening was passed in dancing in the ladies' ordinary of the Windsor Hotel, and in visiting the exhibition.

Thursday afternoon many of the members went on the charming excursion tendered by the Harbor Commissioners up the river, and home down the famous Lachine rapids. Most of the afternoon was taken up, and every one reported a royal good time.

During the afternoon, too, a most graceful and brilliant reception was given by Sir Donald Smith at his beautiful residence, and was thoroughly enjoyed by a large number of guests.

On Friday afternoon the attraction was a most interesting lacrosse match at the grounds of the Montreal Athletic Association, and in the evening two notable receptions were given by Mrs. F. R. Redpath and Mrs. Bovey.

Nearly all the members of the association at the convention, as well as many prominent citizens of Montreal, were present at the banquet on Thursday night. Windsor Hall was beautifully decorated for the occasion, and the tables were arranged with exquisite care. In the place of honor sat his Excellency the Governor-General of Canada, while Sir Donald Smith presided, with President Huntley on his left, and near by United States Consul Knapp, Prof. Bovey, Mr. Ayer, Mr. Francisco, Judge Armstrong, General Barney, Mr. Gulick, Mr. Redpath, Lord Kilcoursie, Sir William Dawson, Mayor McShane, and other notable guests.

The ménu was most attractive and fully up to the high standard of Montreal hospitality. After its more substantial part had been fully discussed and cigars were alight, Sir Donald Smith took charge of the postprandial exercises. First in order was the presentation to Prof. Bovey by his appreciative American friends of a phonograph of the latest type, in token of their high regard and esteem. After this little surprise, the toasts were formally begun by that to the Queen, followed by that to the President of the United States, happily responded to by Consul Knapp. Next the banqueters cordially drank the health of Lord Stanley, the Governor General, who responded in one of the cleverest and most finished speeches of the evening. After this came the toast to the National Electric Light Association, most appropriately acknowledged by President Huntley. Then came in happy sequence the other toasts, to the city of Montreal; McGill University, the representative of scientific education in the Dominion, most eloquently acknowledged by Sir William Dawson; to the Citizens' Committee; the ladies, to which Judge Armstrong responded in his usual clever vein; to the electrical and the local press; to Sir Donald Smith, to whom every member of the association feels personally grateful, and finally to electrical science, to which Mr. T. D. Lockwood replied in a polished and well considered speech that was an appropriate termination of a really brilliant entertainment.

During the evening President Huntley was made the recipient of a beautiful gold-mounted gavel by his Canadian friends, a hospitable and cordial way of getting even with the association for the little surprise that began the evening. At last, as the small hours grew larger, the guests departed with regret from the scene of festivity.

Notes of the Convention.

The exhibition held in the Victoria Skating Rink, just across the street from the Windsor Hotel, was a remarkable success, indeed it proved to be perhaps the finest collection of industrial apparatus that has ever been got together on this continent. It was formally opened on Monday evening, Sept. 7. The decorations were very elaborate and the hall was beautifully draped with bunting, and in addition the lighting, as might have been expected, was artistic in the extreme. All day on Monday the exhibitors were working hard putting finishing touches to their work or trying to get the necessary parts of their necessary apparatus through the Custom House where the arrangements were of the worst. At eight o'clock the formal proceedings were opened by the mayor of the city, who then presented Sir Donald Smith, who made a brief address, and then turned over the work to General Barney, the very efficient manager of the exhibition. The successive signals for starting the exhibition were given by a little daughter of Prof. Bovey, and as the current from McGill University was switched on the big motors, after they had gotten down to steady work, the lighting of the lamps was gradually turned on, and soon the hall was blazing with many-colored globes; the sight was really a beautiful one and everything worked in the most perfect manner, the machinery was in fine running trim, even if the installation had been of a somewhat hasty character, and no one could have wished a more successful or auspicious opening. On Thursday morning Lord Stanley, of Preston, governor general, accompanied by Lord Kilcoursie and the Hon. Mr. Rice, of the British Legation at Washington, honored the exhibition with a visit. The party was shown the details of the exhibition by Prof. Bovey, General Barney and a few others of the important officers of the meeting. Lord Stanley investigated the exhibition very thoroughly, and created a very pleasant impression by the intelligent interest he displayed in electrical matters.

Everybody must have a Wade dynamo register. Bibber says so, and that settles it.

Robin & Saller, of Montreal, made a very neat display of leather belting and belting supplies.

Frank Magee was on the warpath during the convention, armed with the Ætna arc lamp hanger.

Why were not the ladies asked to the banquet? In the opinion of many it was a mistake.

The E. P. Gleason & Co. showed some very neat designs in glass for electric lighting purposes.

The exhibit of The E. S. Greeley & Co. was resplendent in a sign E. S. G. in colored incandescent bulbs.

H. Ward Leonard had a hard time hobbling around on crutches, but he "got there," and so did his exhibit.

James Leffel & Co., of Springfield, Ohio, were doing missionary work with a particularly fine new catalogue.

Mr. H. A. Rogers, New York dealer in railway machines and electric supplies, had an active representative on the field.

L. E. Willcox & Co., of Meriden, Conn., had, as at Providence, their Speed wire stretcher as their principal specialty.

The Standard Time Company, New Haven, Conn., was showing a large collection of its electric apparatus for time distribution.

J. M. Duncan, of New York, was hustling about proclaiming the merits of the Smith & Vaile steam pumping machinery.

Messrs. Phillips, Carroll, Ackerman and Hathaway, of the American Electrical Works, were the "big four" in hospitality as usual.

The New York Belting and Packing Company, of New York, as many another firm, distributed a considerable line of circulars.

The Johns-Pratt Company, of Hartford, Conn., made a very fine display of vulcasbeston worked into a great variety of forms.

The Nubian Iron Enamel Company was heralding the usefulness of its Nubian enamel as a protection for exposed metal wires.

R. C. Burns, of the Peru Glass & Carbon Company, Peru, Ind., was attending strictly to business. Mr. Burns is a keen business man.

Alexander, Barney & Chapin had a small but very neat exhibit at their parlors in the hotel where Mr. H. J. Issertell was in attendance.

The Consolidated Fruit Jar Company was very efficiently represented by Mr. Frank Wisner, who was talking everything but fruit jars.

The Hazeltine Electric Company, St. Louis, was showing its carbon protector, of which much has been heard during the past few months.

Did you see the unique charm on Mr. Hammer's watch chain—an emblem of his name? His office is in Temple Court, New York City.

Mr. C. A. Schieren, Jr., advertised his celebrated Belting Company by giving away a neat cigar case with their "electric" stamp on it.

Messrs. Peck and Chase were the favorites with the ladies, and many a dark frown was cast on them from their more unfortunate rivals.

Mr. F. W. H. Pointer, General Barney's private secretary, was second only to the General himself in active work and attention to the exhibitors.

A feature of interest in the display of the Toronto Construction and Electrical Supply Company was an arc lamp for use on alternating circuits.

The Card Electric Motor and Dynamo Company, of Cincinnati, was doing the honors with a particularly handsome catalogue of its various machines.

The Gould Packing Company, of East Cambridge, Mass., was displaying samples of Gould packing for steam and water pipes of every description.

Ben Hamilton, of the Sawyer-Man Company, kept busy every minute greeting old friends. Everybody knows "Ben," and everybody likes him.

Mr. W. R. Babcock, a son of the Passenger Agent of the Central Vermont Railroad, did all he could to make the journey to Montreal a pleasant one.

The American Circular Loom Company, Boston, was represented by A. T. Clark. His pockets bulged with samples of canvas jacket woven insulation.

Another Montreal firm which was on the warpath was William Sclater & Co., who exhibited a fine line of asbestos covering, steam packing and the like.

Did you smoke a Standard Paint cigar? They were all right, and were not, as was asserted, made of the P. & B. compound, or wrapped with P. & B. tape.

H. S. Winston did not appear in his usual good spirits. Some people are wondering if there was anything to that experience of his in New York.

The Interior Conduit and Installation Company was active throughout the convention, and made rather a specialty of showing carbon protectors.

The Engineering Equipment Company, of New York, was quietly calling attention to its various specialties, particularly the Habershaw wire and cables.

Mr. W. W. Castle, of P. & B. conduit fame, was quietly going about as a sort of electrical colporteur introducing his specialties to the untutored heathen.

Did Dean of the Electrical Merchandise Company, Chicago, ever tell you of his experience as an undertaker? Ask him about it. It's worth going miles to hear.

The Aluminium Carbon Company, of Buffalo, most ably represented by Mr. Doty, had a large exhibit of carbons in the station of the Royal Electric Company.

It may be interesting to many to know that the Hon. A. B. Cornell, ex-Governor of New York, was a telegrapher in Montreal during the early days of the art.

Mr. H. S. Winston, president of the Illinois Electrical Material Company, was skirmishing about, and picked up several novelties for the Western trade.

Steele & Johnson, of Waterbury, Conn., represented by

A. H. Mills, showed a large variety of neat designs in brass, steel, and sheet-metal working generally.

Geo. W. La Rue is the man who would rather show the merits of the Crocker-Wheeler motor than eat a good dinner, and could always be found at his post.

The Brooks Carbon Works, of Peterboro, Ont., was represented by Mr. J. W. Taylor, an old representative of similar business both in Cleveland and Chicago.

In the crush of greeting the Montreal delegation at St. Johns Mr. James Vulca Godfrey had his high hat smashed. Its probably in the bill, but you don't see it.

One of the enterprising Montreal dealers, Mr. J. C. Fitzgerald, displayed a very handsome line of combination fixtures fitted with the Universal bracket joint.

Captain Candee, of the Okonite Company, wore one of the new Okonite badges, attracting a great deal of attention. He says, "Everybody will wear 'em soon."

What do you think of Cleverly's mud story, or have you heard it? As it's a reflection on another part of our country we won't tell it, but you should ask him about it.

Mr. F. S. De Ronde, of the Standard Paint Company, was distributing tracts in the form of P. & B. invincible cigars, so called because they do not smell like P. & B. paint.

Gould & Eberhardt, of Newark, N. J., in the absence of any really portable exhibit, were distributing literature concerning their new drill press and other machine tools.

The Jewell Belting Company, of Hartford, Conn., was distributing a little tract concerning the merits of its manufactures, and in addition had in charge of Mr. C. L. Towles.

We all know now that the fibrous battery is a stayer, but can Louis Walsh ever have an easy conscience after the constant ringing of that bell for 30 consecutive hours.

The Bryant Electric Company, of Bridgeport, Conn., displayed a remarkably fine sample board showing its excellent specialties arranged in a most striking and fantastic way.

A special attraction brought up in this Convention was the Wade dynamo register for indicating to a station manager the exact time that any given circuit was in operation.

One of the fine displays of the exhibition was that of the Dominion Wire Manufacturing Company, of Montreal, with a fine collection of insulated wires of copper, brass and steel.

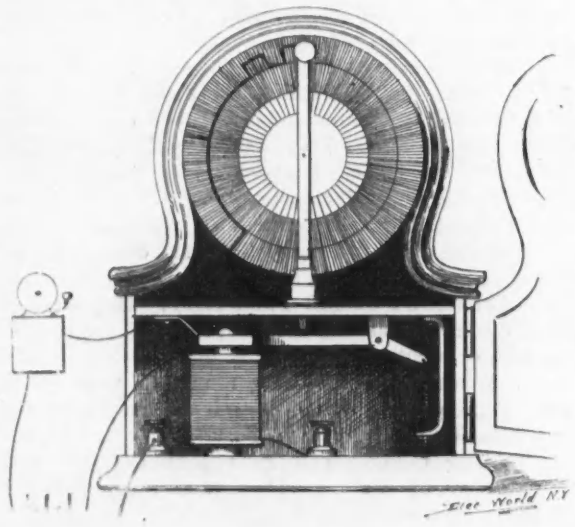
The Globe Electric Cordage Works, of Philadelphia, represented by Mr. Hugh Smiley, was showing a handsome line of flexible incandescent cords of all colors and descriptions.

Mr. S. Rosenstamm, of Lewisohn Bros., was business as usual, and the smile on his face suggested a pocketful of orders for their celebrated "Dollar Boy" copper and copper wire.

When Crane rapped the counter with his cane and sang, "He's a Jolly Good Fellow," for Mayor McShane's benefit, that gentleman was overcome with the rousing reception given him.

Mr. E. S. Keefer, of the New York office of the Western Electric Company, organized a little select party on Thursday, to go to Lachine by rail, and then return by steamer down the Rapids.

Mr. M. J. Sullivan, of the Edison General Co., made one of the happiest speeches of the convention in his reply to



The Ware Dynamo Register Shown in the Exhibit of the Consolidated Electric Manufacturing Co.

the toast "Edison," at the informal to Mayor McShane Tuesday evening.

Miller Brothers & Toms, of Montreal, represented the Hill Clutch Works, and showed a fine collection of photographs of clutch pulleys, cable shafting, and power transmission machinery generally.

The Excelsior Electric Company, of New York, had in the exhibition hall one of the latest patterns of Hochhausen arc light machines that was in itself a sufficient demonstration of its excellence.

The National Carbon Company was out with the September, 1891, edition of the directory of electric arc lighting plants, which has proved itself in the past a great convenience to electrical people.

Abendroth & Root Mfg. Co. distributed a particularly handsome illustrated pamphlet describing its steam boilers, and containing a number of tables that would prove valuable to the general electrical reader.

The exhibit of the La Boiteaux Electric Company, of Cincinnati, O., was interesting because of the fine display of revolving and oscillating motors and fans that were attracting a great deal of attention.

John Muir, "majestic and brainy," the chief of the street railway department of the Edison General Electric Company, made many new friends. Mr. Muir is one of the coming lights in the electrical field.

The display of the Phœnix Glass Company was of the most beautiful description, the show of incandescent lamps of every size, shape and color was perfectly beautiful and the effect obtained was such as to cause a constant throng of visitors to crowd around the exhibit.

Mr. C. L. Tolles, of the Jewell Belting Company, was a favorite, as usual, and many a pocket contains, as his gift, a match safe and wallet. The unanswered question is, Did he really have seven suits or not?

F. A. Magee, of Boston (not N. Y.), now says that he has a new scheme of running a steamer on a heavy dew,

STANDARD · PAINT · CO.
TORONTO CONSTRUCTION & ELECTRICAL SUPPLY CO. 68 & 70 FRONT ST. TORONTO AGENTS
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A View in the Exhibit of the Standard Paint Company.

and that it has been made practical by using "Underwood Cotton leather belts." Ask him about it.

Whitmore & Robinson, consulting electrical engineers, of Boston, were represented by Mr. C. H. Bigelow. This firm has a thoroughly equipped electrical laboratory for standardizing instruments of all descriptions.

Mr. F. Day Voorhees, of the Norwich Insulated Wire Company, made many new friends at the Convention by his cheerful manner, and by his untiring energies in personally seeing that his friends were well taken care of.

Charles A. Schieren & Co., of New York, had a hard time in getting their goods through the "procrastination office" or custom-house, but finally got in shape and showed their perforated leather belt in its best form.

Mr. T. W. Ness, of Montreal, had in the exhibition hall a splendid line of house supply goods, combination telephone switchboards, sewing machine motors, electric turntables for show windows and all sorts of minor appliances.

The P. & B. Exhibit of the Standard Paint Company was looked after by Mr. Frank S. De Ronde, and was a very striking affair, containg a fine line of samples of P. & B. paint, tape, insulated paper and armature furnishings.

The Schultz Belting Company, of St. Louis, was represented by Mr. W. P. Mullen, vice-president of the company, who was loaded with samples of the leather linked belt that has gone so far to make the reputation of the company.

A very pretty impromptu ball was given Wednesday evening at the parlors of the Windsor Hotel, due to the energy of Messrs. Carroll, McGill, Hager and others, who did so much all through the Convention to entertain the delgates.

Two foreign firms had hard luck in respect to the exhibition: Felton and Guilliame, of Cologne, and Cöln & Bender, of Berlin, both had fine exhibits on the road that were, however, left out in the cold by the non-arrival of the steamer.

The Peru Glass and Carbon Company, and Peru Porcelain Works, of Peru, Ind., displayed a fine line of their standard electric light appliances and miscellaneous electrical goods, in charge of Mr. P. C. Burns, general manager of the company.

Mr. E. A. Wilhelmi, representative of Fairweather & Ladew, was on hand to look after the interests of his firm, and threatened at the next Convention to have an elaborate exhibit of the leather belting and other specialties manufactured by it.

Mr. Louis Walsh had a fine exhibit of the fibrous dry battery, of which the Eastern Electrical Supply Company, of Boston, has been appointed agent in New England, and Messrs. Royce & Marean, of Washington, agents for that section of the country.

The Heisler Electric Company, of Philadelphia, was showing a 200-light Heisler dynamo of the regular type; it displayed one Heisler series current and alternating lamp, and also a Heisler regulator. The exhibit was in charge of O. J. Herman.

Mr. P. H. Alexander and H. G. Issertel gave a select concert in room 265 Wednesday afternoon to a few personal friends. Their rendition of "Comrades" will long be remembered by those present, as will Mr. Corey's costume while acting a leading part.

Mr. C. E. Bibber represented the Consolidated Electric Mfg. Company, of Boston, and was making a specialty of the C. E. M. jackknife switch, and the Davis arc light cut-out, which is now in use in all the stations of the Boston Electric Light Company.

R. J. Sheehy, the old-timer, always had an interested crowd around him listening to his tales of long ago. By the way, Mr. Sheehy has something new that he will shortly put on the market that will be of great importance in one branch of the industry.

The Electrical Supply Company, of Chicago, made no exhibit, but its interests were amply looked after by Mr. William Taylor, the assistant manager, who, by the way, is a Canadian by birth and was formerly one of the officers of the Canadian Pacific Railway.

The Page Belting Company, of Concord, N. H., represented by Mr. Currier, exhibited a fine line of leather belting, giving especial prominence to its Acme link belting, and issued a small souvenir, showing photogravures of Acme link belts used for various purposes.

The Reliance Gauge Company, of Cleveland, O., was making a specialty of exhibiting its Reliance water-columns, intended to insure watchfulness on the part of employés, and cause the water to always be carried to a proper level and insuring economy of fuel and repairs.

Mr. M. C. Roach, the affable General Eastern Agent of the New York Central Railroad, rode as far as Poughkeepsie on the special to see that everything started off all right, and every one was giving him credit for furnishing the beautiful special train for the trip to Montreal.

The Ball Electric Light Company, of Toronto, had a very pretty exhibit at the exhibition consisting of its four ampère double armature arc light machines with Bernstein incandescent lamps on an arc circuit, and also several of its new type of single armature incandescent machines.

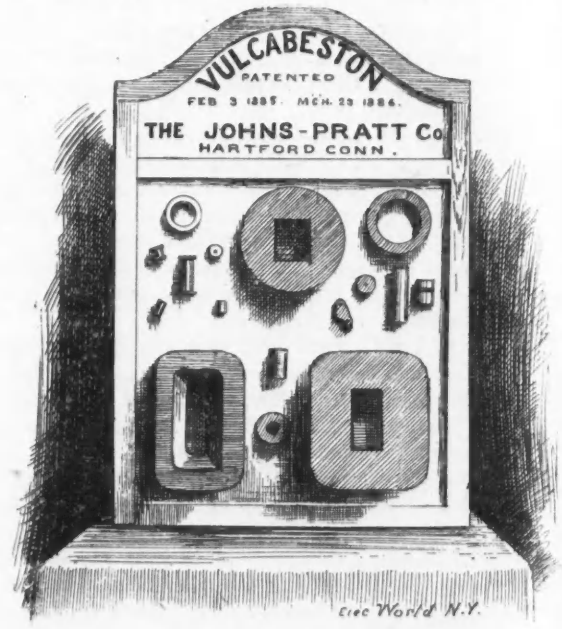
Theo. V. Doty, general manager of the Aluminium Carbon Co., Buffalo, N. Y., attended his first convention this year. The impression he made was a lasting one, and the warm friendship ought to ripen into large orders for his carbons, which, he says, are the "short line" to wealth.

The Hart & Hegeman Manufacturing Company, of Hartford, Conn., represented by Mr. Gerald W. Hart, made a fine display of the Hart snap switch in all its various forms and sizes. The switch has met with a particularly good reception, and has won a kind word from every one who has examined it.

M. E. Baird and A. D. Newton, of Windsor, Conn., were, as usual, very able-bodied representatives of the Eddy Motor Company. With Baird and Newton to preach the merits of the motor, special exhibits could be dispensed with, but incidentally merely one was placed in the display of the Toronto Construction and Electrical Supply Company.

The Eureka Tempered Copper Company, of North East, Pa., represented by Mr. N. S. Possons and J. R. Phillips, had a very elaborate line of its tempered copper goods, commutator segments, dynamo and motor brushes, journal bearings, trolley wheels, trolley wire, feeder wires, soldering irons, and all sorts of specialties made of this unique metal.

One feature of the exhibit that attracted universal attention was the plant for the transmission of power consisting



The Johns-Pratt Company's Exhibit.

of a number of 32 500-volt compound wound railway dynamos, driving a No. 20 incandescent dynamo, supplying a large number of lights in the exhibit and about the hall. The applications of electric power to all sorts of minor work were also well displayed.

The exhibit of the Edison General Electric Company, in charge of managers of the Canadian district, covered a large amount of space in the Victoria Rink, and was arranged under the supervision of Mr. Barr, of the Canadian office. A wide variety of electrical applications were shown, including every feature of the Edison incandescent lighting system, overhead and underground.

One of the very interesting novelties shown in the exhibition was a Ries regulating socket for alternating current incandescent lamps as shown by the Ries Electrical Specialty Company, of Baltimore, which was represented at the Convention by E. E. Ries, the inventor, and Mr. L. H.

Greensfelder; this regulating socket is simply a choking coil of variable power arranged in very compact shape, and enables the light to be turned down with a very considerable saving of energy.

The Standard Underground Cable Company, of Pittsburgh, displayed sections of a gigantic cable of which it was preparing 82 miles for the service of the Brush Electric Company, of Minneapolis, and also distributed a few of its very useful pocket note books that have previously been welcome at the Convention.

F. Day Voorhees, of the Norwich Insulated Wire Company, says his company is now rebuilding the old Callender factory in New Jersey, and when completed it will be "a thing of beauty and a joy forever," besides being very substantial. This company proposes soon to be a considerable factor in the electrical field.

The Eugene F. Phillips Electrical Works, of Montreal, made a beautiful display of electrical conductors insulated in their factories, and great stacks and coils of Faraday cables, rubber-covered conductors, office annunicators and magnet wires wound in every way were grouped, and formed a particularly interesting exhibit.

J. F. Kelly, "the only" of the Edison General Electric Company, went to Montreal to bid his friends good-bye before departing for the "glorious climate of California." He said he didn't have a new story, and there is a lurking suspicion that there will be a few people in California who will succumb after hearing some of his stories.

Mr. George Cutter, of Chicago, had a few specialties with him to which he desired to call the attention of his friends. One of them was an arc lamp pulley that automatically holds a lamp suspended even though the wire rope might be broken; a magnetic cut-out for street railway circuits; a new form of cable connector was also on his list.

The Falls Rivet and Machine Company, of Cuyahoga Falls, O., distributed some handsome cards descriptive of its clutch pulley, and showed two of the four great lines of shafting in the municipal station at St. Louis. This company was represented by Mr. E. L. Babcock, president; Mr. Long, vice-president, and Mr. Wier, Western manager.

J. W. Beane and his office corps were kept busy during the convention week acting not only as the executive office but as general bureau of information and question department. They never showed any signs of being bored, in spite of the thousand and one questions that were asked, and in all things proved efficient in furthering the success of the Convention.

J. W. Queen & Co., of Philadelphia, had a neat and interesting exhibit in charge of Mr. E. G. Willyoung. Some of the specialties exhibited were a new design of the Siemens electrodynamometer, a new portable testing set, so arranged as to be nearly free from magnetic disturbances, and a combined portable galvanometer and battery for use in locating faults.

The Russell Electric Company, of Boston, showed a number of Russell arc lamps arranged in circuit to show advantages to be attained by the use of carbon discs. These lamps have now been in daily service in hundreds of places, and reports received from them have been of the most gratifying character as regards distribution of light and general economy.

A CORNER IN THE EXHIBIT OF THE PHŒNIX GLASS COMPANY.

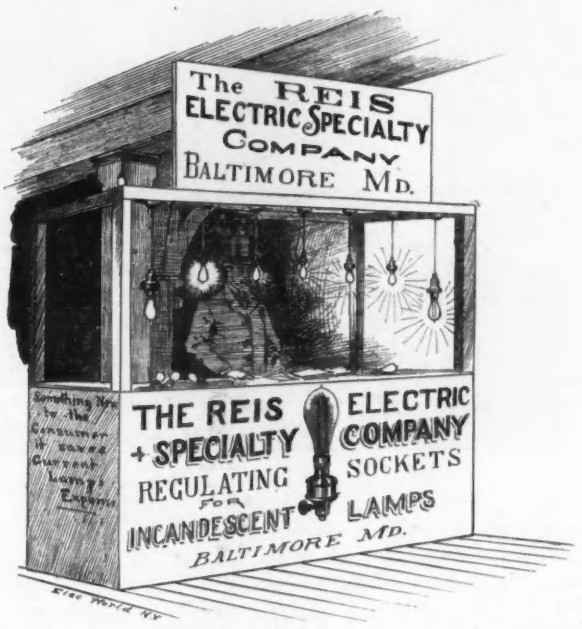
The Western Electric Company was represented by Mr. S. A. Chase, who could if he were so disposed give commercial travelers of electrical supply companies points on exhibits, for he had a set of sample trunks that contained a specimen of every article manufactured by the company, except a Bell telephone and a dynamo. As usual he was right after business.

How hungry the Boston boys looked when the special train arrived at Rutland, and how they did rush for the dining car and ask for "beans!" But every one enjoyed the scenery at Manchester, Vt., even if we were compelled to wait for an hour, and how fortunate it was that we had with us such a man as T. Carpenter Smith, to give the engineer a point or two, and enable us to reach Montreal before midnight.

One of the gentlemen to whom great credit is due is Mr. John Carroll, the genial manager of the Eugene F. Phillips Electrical Works, who labored incessantly, devoting his entire time to caring for the members and their friends. He was thoroughly enthusiastic in his work, and his cordial and courteous attention will be long remembered by every delegate present at the Convention.

John A. Roebling's Sons' Company, of Trenton, N. J., was, as usual, on the warpath at the Convention, and was represented in the most competent fashion by Manager H. L. Shippey, of the New York house, and George A. Bailey, manager of the Chicago house, who has in the last three years built up an enormous business for his company, and the electro-entomologist, Dr. F. A. C. Perrine, the very popular electrician of the company.

The Ferracute Machine Company, of Bridgeton, N. J., had a rather neat exhibit on view; the company intended to show some presses running with dies for cutting armature discs and the like, but power was not at hand, so they were compelled to show instead a fine collection of photographs of presses, dies and sheet metal machinery of various sorts



THE EXHIBIT OF THE REIS ELECTRIC SPECIALTY COMPANY.

and a very large collection of samples of metal work in the various forms used in the metal industry.

Messrs. Willcox & Dean represented the Electric Merchandise Company of Chicago, and had a fine exhibit in parlors 14 and 16 of the hotel. As the company deals in electric railway supplies the exhibit was naturally limited, but samples of the Burton heater, which has lately been introduced on a considerable scale in the service of the West End Railway Company of Boston drew widespread attention. A few other railway specialties were shown.

The International Okonite Company, of New York and London, as usual, had one of the most elaborate exhibitions, and was admirably represented at the Convention by Capt. W. L. Candee, George Manson and Jean Wetmore. The exhibit consisted of almost everything imaginable in the line of wires, armored and lead covered cables, light and heavy insulated copper conductors and Okonite lamp cords, Manson and Okonite insulating tape, and other specialties.

The Crocker-Wheeler Company, of New York, was very efficiently represented by G. W. La Rue and Dr. Wheeler himself. The exhibit was a fine one, among the articles being a 24-inch La Rue exhaust fan and motor on one base, with a speed of 600 revolutions per minute; a 1 h. p. constant current of a type just brought out for use on arc circuits; a one-sixth h. p. constant current motor, regulated either by hand or treadle, and a large variety of accessory apparatus.

The Norwich Insulated Wire Company, of New York, had more than the customary amount of delay at the custom-house, and its exhibit did not escape the official toils until Wednesday afternoon, but by evening everything was in order and a fine line of cables and wires was ready for inspection. The booth of the company was handsomely draped in the national colors, interspersed with banners and streamers and elegantly fitted up with rugs and easy chairs.

One of the gentlemen to whom particular credit is due and who deserves the most cordial thanks of all the delegates is C. O. Baker, Jr., who attended to the arrangement of the special train from N. Y. City to Montreal. It was beautifully equipped and furnished and Mr. Baker's management left nothing to be desired. The dining car service was especially fine, and the way in which Mr. Baker looked out for the comfort of the party will be long remembered by every one who was present.

The Toronto Construction and Electrical Supply Company was well represented by Mr. Frederic Nicholls, who is a familiar and welcome member of most of our electrical conventions. The company had about 400 feet of space near the main entrance, and it was beautifully fitted up with Ward arc lamps, Grimshaw wires and cables, Eddy motors, testing instruments, Patrick & Carter annunciators and house goods and other specialties. Messrs. Stannard and Chrytie were looking after the exhibits.

The Germania Electric Company, of Boston, had a fine display consisting of a series of shelves arranged in a white and gold cabinet, on which shelves were connected the various forms of incandescent lamps manufactured by the company. A circuit-closer was so placed that when a shelf is in a horizontal position the lamps appear in a background of red, white and blue automatically connected in circuit; the Germania shade holders and Freeman transformers were also shown. The exhibit was in charge of O. K. Stuart and H. Bottomley.

The New York Insulated Wire Company, manufacturers of the Vulca wire ducts, had a fine exhibit, including a complete fishing system with junction, distributing and anchor boxes; the vulca ducts are fireproof and are finished with a fine hard surface susceptible of a high polish and fine mechanical processes. Both single and double tubes were shown in 10-foot lengths, and tubes were also shown surrounded by Portland cement and plaster of Paris. The company was represented by Messrs. Godfrey, Place, Bowse, Meeker and Noll.

F. H. Leonard, J. D. McIntire and F. N. Harkins had charge of the exhibit of the Electrical Engineering and Supply Company, of Syracuse, N. Y., which consisted of a long series of sockets and cut-outs, central station switches, ceiling rosettes, and innumerable other small pieces and apparatus; they also made a special display of the Packard incandescent lamp, which has worked its way into popular esteem, and for which the company secured the general Eastern agency. The Jenney electric motors were also a feature of their exhibit.

Pass & Seymour, Syracuse, N. Y., exhibited a large line of their latest specialties in electrical china work; many of the samples being decorated in imitation of hard woods; the articles shown were socket bases, cams and keys of every kind, china sockets, china bases, transformers, large insulators for covering lightning arresters and for railway work. As an indication of their capacity to turn out good work it may be stated that in nine months they shipped 11,000,000 small pieces, and are now turning out goods at the rate of 350,000 pieces per month.

The thanks of the exhibitors at the Montreal Convention are extended to Mr. C. W. Hager, general manager of the Royal Electric Company, for his untiring energies in looking after their interests, his company wiring all the exhibits and furnishing current without charge. To get everything in ship-shape order and start the exhibition on time it became necessary to employ a large extra force of men. Mr. Hager did not hesitate at the expense, but secured the necessary help, and must have taken great satisfaction in seeing the great exhibit of electrical appliances start without a hitch.

One of the novelties in the exhibition hall was the California arc lamp which has attracted considerable attention from its extraordinary form and abnormally long life of the carbons—90 hours it was claimed—the arc traveling back and forth along the edges of two flat discs, giving a very clear light and no visible shadows. These lamps are constructed to burn on arc circuits of long tension, or on constant potential circuits. The invention is controlled by the Interior Conduit and Insulation Company, of New York, and its representatives, Messrs. Little and Oscanyan, were busy telling of its good features. Another specialty that kept them active was the Johnson vice-lock switch.

W. J. Morrison, Canadian agent of the Fort Wayne Electric Company, had a fine display of their system of the Wood arc light dynamo with a full load, a Wood arc light dynamo, Wood arc lamp, Slattery alternator supplying current to a considerable load of incandescent lamps,

A VIEW IN THE OKONITE COMPANY'S EXHIBIT.

Slattery transformers so arranged as to be conveniently investigated, and a considerable number of other pieces of apparatus. The dynamos were driven by Thomson-Houston motors through the agency of Schieren belting. The current of this particular exhibit was supplied by the electric light plant at the Windsor Hotel. The Wood arc light dynamo in the exhibit has been presented the McGill University, and the alternator has been sold to a local company.

The Weston Electrical Instrument Company, of Newark, had its customary display of Weston standard instruments arranged on a beautiful silk plush covered cabinet. It included direct reading station ammeters ranging as high as 1,500 ampères, direct reading standard voltmeters with scales ranging from one-hundredth of a volt to a full volt, and so on up to 600 volts; Weston multipliers for increas-

ing the reading scale of the voltmeters, low reading ammeters, and milliampère meters, and their other well known instruments. Nothing need be said of the Weston instruments, as their reputation is too well known among all those who desire accurate and reliable measuring apparatus.

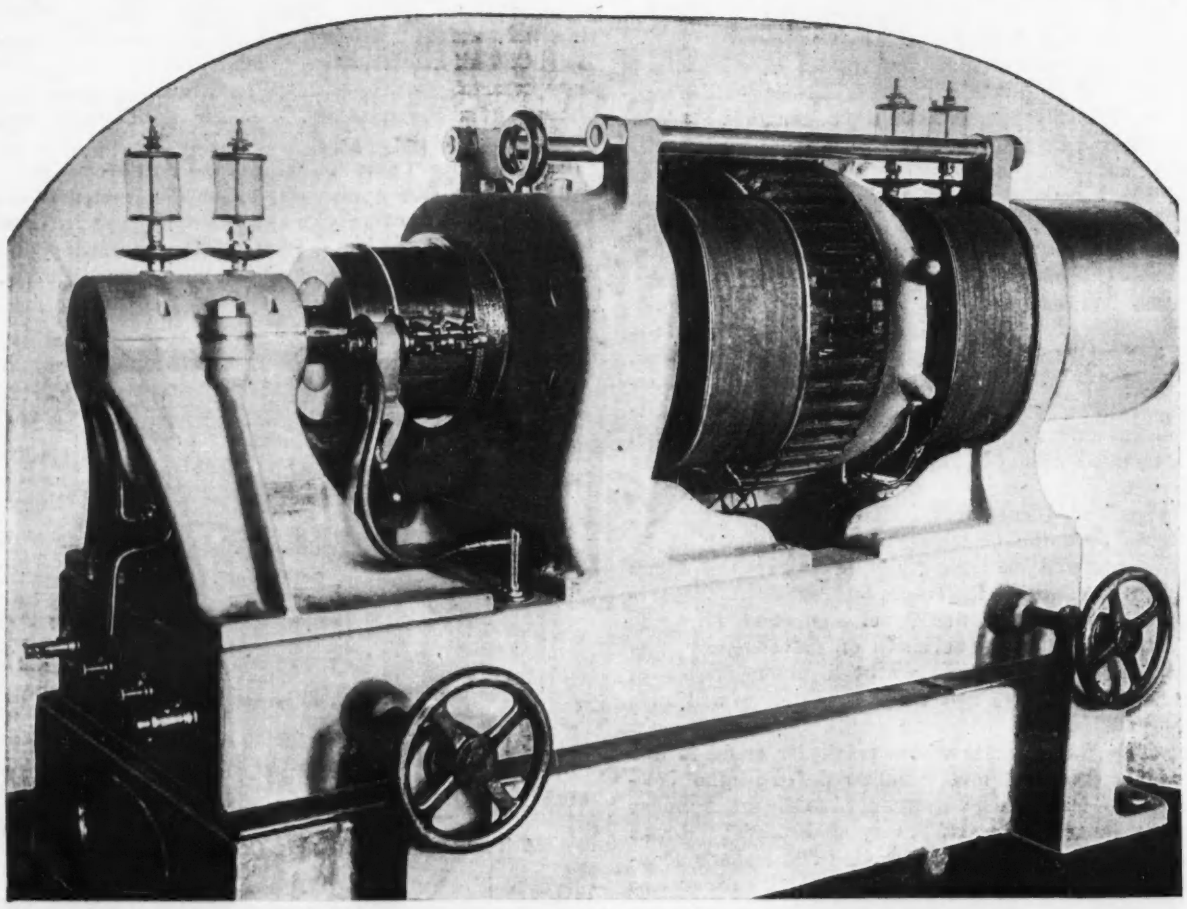
The Thomson-Houston International Electric Company had a large section of floor and an exhibit of a particularly fine working display, which showed direct and alternating current dynamos for various purposes, and motors built for all sorts of uses manufactured in the company's most approved commercial form. At the station the exhibit was a number of fine switchboards, over which the various circuits were directed. Perhaps the one thing that attracted most universal attention was the Van Depoele reciprocating rock drill, shown in active operation swiftly biting its way into a hard granite block, under the operation of a single man. This one machine probably attracted as much interest as any single piece of apparatus in the hall. The Thomson-Houston Company as usual did not go in at all for sensationalism, but merely showed practical apparatus.

The exhibit that attracted very great interest was that of the newly constituted firm of H. Ward Leonard & Co., represented by Mr. Leonard himself, who pluckily went through the Convention in spite of his accident, and Mr. Vance. Mr. Leonard has devised a very simple and beautiful method of controlling the speed and torque of electric motors; his own apparatus was not ready so he secured from the Edison company a machine to illustrate his work. By Mr. Leonard's method of regulation a standard shunt wound motor can be worked at uniform speed through a range of from 50 to 2,000 revolutions per minute, and while operating at any given speed will hold it constantly and quite independently of the load. He showed the device operating an electric hoist, and the way in which the speed of the load could be regulated and its direction and motion reversed was simply beautiful. No such flexibility of government has ever been seen before on any other motor, electric or otherwise, and Mr. Leonard deserves the greatest credit for what is really a most ingenious and useful system of governing.

Generator and Motor for the Transmission of Power.

For some years electricians have been working on the line apparatus for power transmission. The Brush Electric Company has had this matter in mind for a long time, but has not been fully satisfied with the results obtained until Mr. S. H. Short, the chief electrician of the company, submitted designs for the apparatus illustrated herewith.

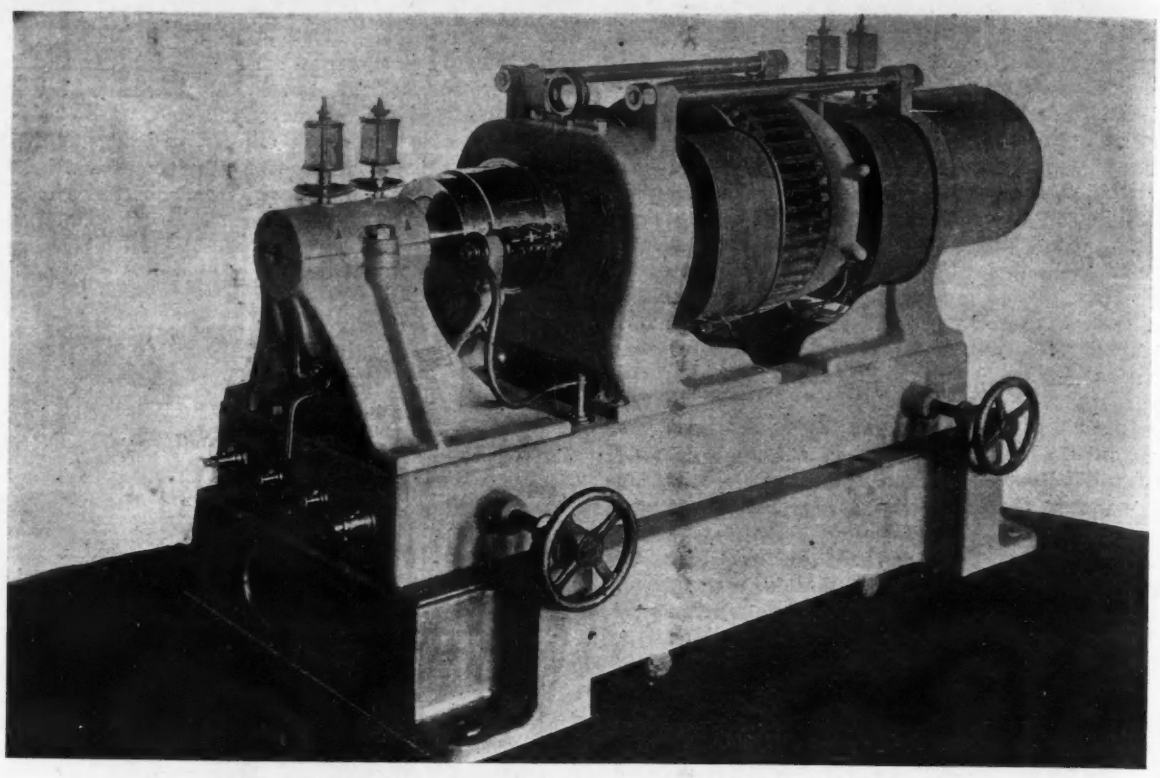
The generator shown is capable of furnishing 100 h. p. at



THE SHORT GENERATOR FOR THE TRANSMISSION OF POWER.

its pulley. It is what is termed the closed coil armature type. The core of the armature is made up of thin sheet iron wound on a foundation ring and firmly riveted. The edges of this ring are then milled out slightly so as to allow for the bobbins of wire. The wires leading from the armature to the commutator are carried along the shaft and are very carefully and thoroughly covered, so as to protect them from dirt or damage of any kind. The bearing on the commutator side of the dynamo is placed outside of the commutator so as to allow a clear way for the connections between armature and commutator. These generators are very compactly built and the ventilation obtained is excellent. Any part of the machine can be inspected without disarranging other parts, and, in case of accident, the armature or magnets can be removed quickly and repaired with little trouble. Any one of the armature bobbins can easily be rewound without disturbing the remaining bobbins.

The construction of the motor is very similar to that of the generator. The motor requires no outside governor of any kind. It is so built as to take care of its own regulation. The generators and motors will be wound for an E. M. F. of 1,000 volts, thus allowing the carrying of power over a considerable distance by means of a comparatively small wire. The new type of commutator with which both motor and generator are fitted, runs with practically no spark, so that there is no trouble at that usually troublesome point.



THE SHORT MOTOR FOR THE TRANSMISSION OF POWER.

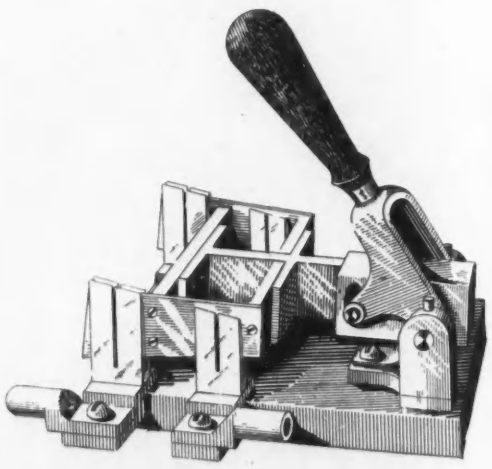
Electricity in the Operation of a New Microscope.

A magnificent microscope has just been completed by the Munich Poeller Physical and Optical Institute for the World's Fair at a cost of $8,750. It possesses a magnifying power of 11,000 diameters. Electricity plays an important part in the working of this instrument. Electricity furnishes and regulates the source of light, which, placed in the focus of a parabolic aluminium reflector, reaches an intensity of 11,000 c. p. The electricity also provides the means of an ingenious automatic mechanism for the centring of the quadruple condensers and illuminating the lenses. There is an arrangement for the exact control of the distance of the carbon point. The most important novel feature is the cooling machine, which is indispensable on account of the extreme heat generated in connection with the intense illuminating arrangement. A machine regulated by a Helmholtz electric centrifugal regulator provides the several microscopic and polariscopic systems of the apparatus with a fine spray of fluid carbonic acid, which immediately after its release from the copper vessel, in which it is held under a pressure of 23 atmospheres, becomes converted into gaseous matter, so intensely cold that only .00007 gramme of carbonic acid per second is required to give the result. The magnifying power of the apparatus with ordinary objectives, as has been stated, is about 11,000 diameters, but with the oil immersion it can be increased to 16,000.

Hunt Engineering Company's Double Pole Switch.

A new double pole quick breaking switch has just been patented and brought out by the Hunt Engineering Company, of Brooklyn, and is a handsome piece of workmanship. The mechanical devices used for releasing the knives from the brushes and making a quick break are, it is claimed, entirely original with the Hunt Engineering Company, and while they are extremely simple, they are most effective and satisfactory.

The whole switch is mounted on a slate base with the terminals on the side, and a pair of knives, insulated from each other and carried on a highly polished bar, make and break the contact. By an ingenious device, a fuse block is attached to the slate base of the switch and one terminal, so that at a slight cost, fuse attachments can be added.



Hunt Engineering Company's Double Pole Switch.

The switch is made of highly polished brass and engraver's copper, and presents a beautiful appearance. It is compact, not liable to get out of order, and is intended to be used in all grades of electrical work or for lighting and power stations. The switches are made in four different sizes, carrying one, two, three and four hundred ampères, or special sizes will be made to order.

A Huge Press for Cutting Armature Discs.

The press shown in the illustration on the next page was built for the Edison General Electric Company by the Ferracute Machine Company, of Bridgeton, N. J., from the designs of its president, Mr. Oberlin Smith. It is especially adapted for making sections of discs for very large laminated armatures, cutting them complete from the sheet at one operation and at the same time perforating them. Various sizes can of course be made, according to the dies used, up to a diameter of nearly 8 feet, the width in the

clear between columns from right to left being 100 inches.

This machine is, we believe, the largest ever built for work of this kind, and is one of the many indications of the modern tendency toward the common sense practice of using armatures of large diameter mounted upon or coupled directly to an engine shaft, thus dispensing with counter shafts, belting, etc. It is of the type known as a double crank press, the ram being driven at both ends from two cranks upon the same shaft and thus kept in absolute parallelism. It is of the same general design as are a large number of other sizes built by the same makers, but is longer than anything heretofore produced.

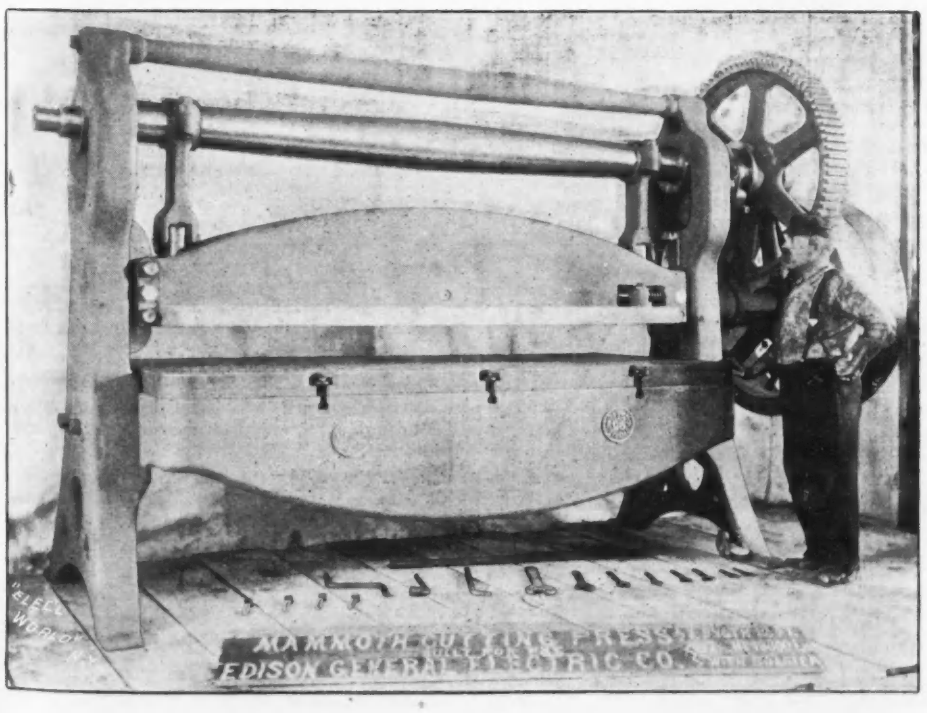
It will be noticed that the bed and the ram are heavily trussed to obtain great rigidity, and that the columns and connections are of handsome and massive design. The shaft is of forged steel; the clutch and other parts subjected to greatest wear are of hardened steel, and all bolts, nuts, etc., are case hardened. The gearing is cut from the solid metal, and is practically noiseless, while the fly wheel and loose pulley are wide and large enough for ample belt power, being 44 inches in diameter by 7 inches face, and weighing about 1,200 pounds.

The slides of the ram are of unusual length, and are furnished with an accurate adjustment, so swiveled that they can easily be kept in absolute alignment. A brake of ample size is provided and placed in such position that it helps to support the extra weight of the gearing upon the right hand end of the shaft, although the clutch is so arranged that the brake can be run quite loosely, so as not to waste power.

Among the novel features of this and other machines of this class invented and introduced by the Ferracute Company are a clutch whose tripping mechanism is adjustable around the axis of the main shaft, through an angle of some 60 degrees, and allows the clutch to be tripped early or late, according to the particular conditions of speed and ram load, thus insuring an automatic action which always stops the shaft exactly at the top of the stroke without an undue dependence upon the brake; a new worm gear adjustment for the height of ram, by which the latter can be varied through three inches, also a treadle lock which can be instantly set so that the press will make continuous strokes, or so that it will stop each time, as the operator wishes. In using the ram adjustment spoken of, the small crank shown on the floor is inserted in a socket in the centre of the front of the ram, which, after slightly slacking four locking screws at the sides of the pitmans, can be easily run up and down with one hand—even, if desired, when the press is in motion.

Special attention has been paid to making this machine easy to take apart and put together, convenient to run and safe against accidents, there being among other safety devices, a guard over the teeth of the gears where they run together, and a "dead stop" upon the clutch to prevent a second stroke, should it not be adjusted exactly right. There is also a clutch lock which can be instantly adjusted with the fingers, so that the main shaft of the press can be revolved by hand, while the flywheel and gearing is running, without a possibility of the clutch throwing itself into gear.

The total weight of this machine, including bolster plate as shown, is about 19,000 pounds; the total length about 12 feet, and the total height about eight feet. The hole through the bed is 90 inches long from right to left, and 36 inches from front to back. The height from the top of the bed to the bottom of the ram, when the latter is up, is 14 inches, and the effective height of the bolster (which, when used, should be deducted from the last mentioned measurement) is 3½ inches. It is, however, heavily trussed underneath, where it spans the hole in the bed. The flanges of the ram in the front and rear are amply think and strong, and are provided with numerous holes for fastening the upper die or dies.



A HUGE PRESS FOR CUTTING ARMATURE DISCS.

A Coffee Mill Operated by an Electric Motor.

The accompanying cut quite clearly illustrates the new power coffee mill run by an electric motor, manufactured by the Belknap Motor Company, of Portland, Me. These machines with water motors in the base have come into quite general use throughout the country; but this machine with electric motor attachment is a more recent invention, and several have been placed in Massachusetts, New York, Ohio and Indiana.

COFFEE MILL RUN BY AN ELECTRIC MOTOR.

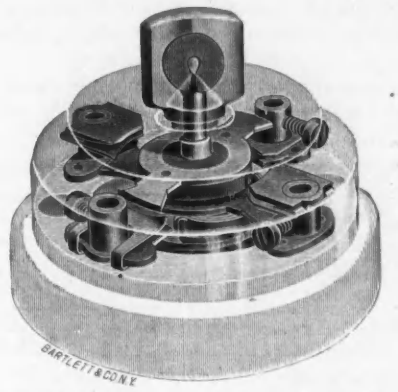
It consists of a hollow upright column which supports the mill, the bottom being flared out so as to give it ample base to insure stability. At the bottom and inside of base is an electric motor of 1 h. p. capacity (although only about one-half of this power is ordinarily required), wound for 110-volt currents. Access can be had to the motor through two openings at the side for oiling and for adjusting the brushes. These are ordinarily kept closed, as two plate glass bulls' eyes show how the machine is running. The motor is placed with its armature arranged vertically and its shaft is in direct connection with the gears, which drive the grinding apparatus, starting and stopping by a small switch rheostat placed in a convenient position on the stand.

The wires conveying the current to the motor being concealed, the whole arrangement presents a very attractive appearance. The machine grinds out coffee at the rate of 200 to 300 pounds an hour, and at the usual rate charged for the electric current there would be very little expense to the average grocer.

The Belknap Motor Company also manufactures dynamos, electric motors, combined water motors and dynamos, all the Belknap "Little Giant" water motor, which has come to be a very popular machine.

The Hart Switches.

The Hart double pole switch, which has just been put upon the market by the Hart & Hegeman Manufacturing Company, of Hartford, Conn., possesses all the merits of the Hart single pole switches, viz.: durable construction; quick rotary movement in one direction; positive action, the switch plates being locked in position until they are under the control of the actuating spring; large contact surfaces and unusually long break for diameter of switch. The length of break in the 15-ampère double pole switch illustrated herewith is three inches, the outside diameter of base being two and seven-eighths inches. The length of break increases with size of switch, until in the hundred-ampère switch it is six and one-half inches. The hundred-ampère switch is mounted on a slate base six inches square provided with clamping devices or binding posts which will take wire up to 0000 B. & S. or flat bar up to three-eighths by three-quarter inches, and are so arranged that the wire or bar may be brought down the face of switchboard or enter the clamps from the back of the board, without bending it in either case. This feature facilitates neat and rapid construction. The long break and quick action allow the double pole switches of all sizes to be used on railway or power circuits of 500 volts and on primary alternating circuits of 1,000 volts.



HART SNAP SWITCH, 15 AMPERES CAPACITY.

Queen's Improved Portable Testing Set.

Something over a year and a half ago Messrs. Queen & Co., of Philadelphia, brought out their now well known series of portable testing and resistance sets, which have been used very largely for all classes of resistance work throughout the country. Almost the only feature of these instruments which has been suggested as capable of improvement for use under certain conditions, has been the galvanometer forming a part of these sets. As heretofore made, this galvanometer has been of the astatic type, fibre suspension, and arranged to automatically take the weight of the needle from the fibre when the lid of the case was closed. A control magnet enabled the needle to be made still more astatic. The sensitiveness of this galvanometer was very great, and it has been found possible to make very accurate determinations of resistance by its use together with the set. Its astatic properties, however, rendered it very susceptible to magnetic disturbances and mechanical vibrations.

QUEEN & CO.'S NEW TESTING SET.

With a view to doing away with this susceptibility without detracting from the efficiency of the set, Messrs. Queen & Co. have been devoting considerable attention to the designing of a new galvometer for use with their sets. The galvanometer finally devised, and shown as part of the set in the cut, is of the D'Arsonval type, very dead-beat in its action, remaining almost absolutely steady during all mechanical and magnetic disturbances. The set fitted with this new galvanometer may be used in factories where there is great mechanical vibration or in central stations, and in the vicinity of dynamo machinery where the magnetic field is very intense. In some recent tests made by Mr.

Willyoung, of Queen & Co., this set was placed upon one large running dynamo while used to measure the insulation and resistance of another dynamo not running. In some other tests of the set it was placed upon a table and measurements made while the table was violently shaken. In both of these tests it is said that measurements were easily and quickly made within an accuracy of one-fifth of one per cent.

The set with the new galvanometer is particularly adapted for use in marine work, as the pitch and roll of the vessel will not appreciably affect the stability of the needle.

This new galvanometer is, like the astatic form, removable from the set, and may be used separately for any kind of work desired. This galvanometer cannot, of course, be made quite as sensitive as the astatic form; it is, however, sensitive enough for all but work of the very highest accuracy. To accommodate those doing the most accurate work the set will still be sold with the astatic galvanometer, which latter has also been improved by making the control magnet larger and completely removable from the galvanometer if desired. When the control maget is to be used it is removed from its fitting in the lid of the instrument and can be instantly slipped into position over the galvanometer by means of a pair of spring catches. This galvanometer has also been so modified that it is practically impossible to break the glass covering the dial—a mishap sometimes occurring with the old type.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

Westinghouse Negotiations.—It is reported that the Westinghouse Company may resume the negotiations with the Pullman Company that were dropped last fall on account of the financial difficulty in which the former company became entangled. At that time the Pullman Company had practically decided to erect a large plant to be leased to the electric company. By this arrangement the manufacture of cars for electric lines could be added to the numerous other industries at Pullman.

The Erie Telephone.—The Boston *News Bureau* publishes the following item: "From the testimony of Mr. Bent before the arbitrators it was learned that the Cleveland division of the Erie Telephone Company cost the syndicate $412,500. At previous hearings it was learned that the northwestern division cost $450,000 and the southwestern division $700,000, a total for the whole Erie Company of $1,552,500, or over $32 per share for the present $5,000,000 of Erie stock. It was sold on an average of $55 per share. These purchases were made in 1883, and the company had at that time 8,800 subscribers. Now it has connected over 13,500. Purchasers of Erie at 55 have received over six per cent. in dividends upon their investment from the date the purchases were made, as the company has paid in dividends over $1,200,000."

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

TELEPHONE STOCKS.

Chicago	$230@	$238	Cumberland	$60@	$62
Central Union	52@	53	Wisconsin	118@	120
Michigan	83@	84	Bell of Missouri	160@	165
Great Southern	30@	32	Iowa Union	20@	22
Colorado	34@	36	Missouri and Kansas	54@	56
Rocky Mountain Bell.	40@	43			

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$94@	$95	Chicago Edison Co	$145@	$150

NEW INCORPORATIONS.

The Rowe Manufacturing Company, of Portland, Me., has been formed with a capital stock of $500,000, to manufacture and deal in electric lamps of all kinds. John W. Fletcher and Charles E. Rowe, of Chelsea, Mass., are the organizers.

The Oklahoma Water and Light Company, of Chicago, Ill., has been formed with a capital stock of $300,000, to construct, operate and maintain water and gas works and electric light plants. The organizers are Charles H. Wood, Horace S. Oakley and J. Gibson.

The Carthage Electric Light and Power Company, of Carthage, Ill., with a capital stock of $10,000, has been organized to purchase, erect, maintain and operate an electric light and power plant. The promoters are Thomas F. Dunn, Junius C. Ferris and Charles S. De Hart.

The Imperial Electric Company, of Camden, N. J., has been organized with a capital stock of $25,000, to manufacture, buy, sell, lease, etc., etc., and trade in machines. J. S. Spruance and J. C. Dorphley, of Camden, N. J. and J. Mustard, of Philadelphia, are the incorporators.

The Orne Electric Construction Company, of Chicago. Ill., has been incorporated with a capital stock of $11,000, to manufacture electric appliances and speaking tubes, and do a general merchandise business. Edward T. Orne, William E. Duncombe and William N. Wegg are the incorporators.

The Dow Adjustable Light Company, of Boston, Mass., with a capital stock of $5,000, has been incorporated for the purpose of manufacturing, buying, selling and dealing in adjustable drop lights, electrical appliances, mechanical appliances, etc., etc. The promoters are Willard E. Dow, Charles F. Morrill and Arthur C. Smith.

The Electrical Engineering Company, of Chicago, Ill., with a capital stock of $50,000, has been formed to prosecute the business of steam and electrical construction, dealing in steam and electrical machinery, appliances, material and supplies. Richard H. Pierce, George W. Seymour and Frank K. Biggs are the incorporators.

The Defiance Light and Power Company, of Defiance, O., has been formed with a capital stock of $100,000, for the purpose of supplying gas and electricity for fuel, light and power, and constructing an electric street railroad, etc. The promoters are E. N. Lewis, C. P. Harley, H. P. Miller, Henry J. Smith, Henry Fosz, Orlando Dyarman and R. H. Gleason.

The Ford and Washburn Electric Company, of Cleveland, O., with a capital stock of $200,000, has been formed for the purpose of manufacturing electrical instruments, machinery, cars, boats, engines, etc., propelled by electricity, etc. Lester A. Cobb, Geo. A. Ford, Edward S. Ford, George A. Washburn and George Hoyt, are the incorporators.

Chicago, Ill.—The Chicago Riverside and Western Street Railway Company has been incorporated with a capital of $500,000, with Lewis Lusk, C. E. Sargent and G. N. Morgan as incorporators. The company proposes to build an electric road, beginning at the terminus of the Ogden avenue car line, west of Douglass Park, to run parallel to the Burlington Road to Riverside,

The Piedmont Spring, Water and Power Company, of Oakland, Cal., has been incorporated with a capital stock of $1,000,000, to construct and operate machinery for generating electricity and operating electric motors. Among the promoters are E. H. Benjamin, W. F. Boardman, E. G. Vincent, W. J. Dingee, all of Oakland, Cal., and Geo. D. Metcalf, of Berkeley, Cal.

The Northwestern Railway Company, of Chicago, Ill., has been formed, with a capital stock of $25,000, to construct, maintain and operate street railways in the towns of Leyden, Proviso, Cicero and Maine, and the city of Chicago, to be operated by any motive power except steam locomotives. The promoters are Eugene B. Weeks, John L. Pearson, and Alfred A. Ellsworth.

The Columbus and Johnstown Electric Railway, of Columbus, O., has been formed with a capital stock of $200,000; its purpose is to construct, acquire, lease, own, operate and maintain a railway from the city of Columbus to Johnstown, by the way of Gahanna and New Albany, for the transportation of freight and passengers. W. Shepard, Felix A. Jacobs, Rufus S. Clark, S.H. Ewing, W. B. Rusler and J. W. Lake are the incorporators.

A New Montreal Organization.—The recent electric light convention at Montreal will undoubtedly bring forth fruit in the establishment of additional electric light, electric railway and other electrical enterprises throughout Canada. On the day the Convention adjourned, the Montreal Metal Works, a combination of the Bell Telephone Company of Canada, The Royal Electric Company, the E. F. Phillips Electrical Works, of Montreal, and the Bridgeport Brass Company, of Bridgeport, Conn., was organized. Mr. C. F. Sise, president of the Bell Telephone Company of Canada, is president, and Mr. John Carroll, of the Phillips Company, secretary and treasurer.

AFFAIRS OF THE COMPANIES.

The Western Union will pay its usual dividend of 1¼ per cent., payable Oct. 15. The books will close Sept. 20. The surplus after paying the dividend will be a large one.

The American Bell Telephone Company will pay a dividend of $3 per share Oct. 15, to stockholders of record Sept. 30. Transfer books will be closed from Oct. 1 to 15, inclusive.

Augusta, Me.—At a meeting of the directors of the A. H. & G. Electric Railroad on Sept. 1, Thomas J. Lynch was elected to fill the vacancy caused by the death of the late E. C. Allen.

The Rawlins Electric Light Company has elected the following officers: John E. Osborne, president; I. C. Miller, vice-president; J. C. Davis, secretary; A. M. Startzel, treasurer, and C. E. Dodge, manager.

The Beaver Valley Electric Light and Power Company, of Beaver Falls, Pa., is about to increase its capital stock to $100,000. It has arranged to put in a steam power plant at a cost of $50,000, and will furnish both arc and incandescent lights.

Schenectady, N. Y.—The stockholders of the Schenectady Street Railroad, at their meeting on Sept. 5, elected the following officers: John Kruesi, president; William E. Gilmore, treasurer. It was unanimously voted to increase the capital stock to $300,000. This road has about five miles of electric road now in operation, and will increase it as soon as the circumstances warrant.

The Application of the Thomson-Houston Company to place its preferred and common stock upon the regular list is with the Listing Committee of the Boston Stock Exchange. If its action is favorable, it will require the ratification of the Governing Committee, which does not meet until the first Wednesday in October. The financial statement presented by the Thomson-Houston Company, in accordance with the requirements of the Stock Exchange, is the old one of February, 1891. The indebtedness has since decreased about $500,000.

The Boston & Great Falls Electric Light and Power Company, a Boston undertaking at Great Falls, Mont., has a capital of $150,000 in $25 shares, and has earned so far this year the following:

1891.	Receipts.	Expenses.	Profits.
January	$1,149	$1,074	$75
February	2,506	1,576	929
March	2,410	1,875	534
April	2,907	2,080	827
May	2,548	2,269	278
June	2,896	1,760	1,136
July	2,953	1,568	1,385
Totals	$17,372	$12,205	$5,166

In May the old engine broke down, shutting off the lights on one circuit for about 15 days. The new engine was set running about June 1. There were in use July 31, 1891, 99 arc lamps and 1,264 incandescent lamps. It is intended that a dividend of $1 per share be paid in January. No stock of this company is upon the market.

Western Union Report.—The following is the report of Western Union for the quarter ending Sept. 30, partly estimated:

	1891.	1890.	1889.	1888.
Net revenue	$2,000,000	$2,000,000	$1,750,000	$1,550,000
Int., sinking fund.	242,388	243,200	210,000	204,802
Balance	1,757,612	1,756,800	1,540,000	1,345,198
Dividend	1,077,405	1,077,400	1,077,385	1,077,386
Surplus	680,207	679,983	462,615	267,832
Total surplus	12,097,948	10,642,383	9,074,016	7,666,380

Net earnings Sept. 30 quarter have been: 1887, $1,400,000; 1886, $1,200,000; 1885, $1,450,000; 1884, $1,750,000; 1883, $1,650,000. The estimated net for June 30 quarter was $1,500,000, but proved to be $1,549,149.

The exact figures for the June 30 quarter permit the publication of the annual report for the year ending June 30:

	1891.	1890.	1889.
Net revenue	$6,605,583	$7,312,725	$6,218,041
Interest and sinking fund	931,218	915,135	795,668
Balance	5,674 365	6,397,590	5,422,376
Dividends	4,309,606	4,956,008	4,309,520
Surplus	1,364,759	1,441,582	1,112,853
Price of stock, Sept	84⅜	84¼-83¼	87-84⅛

Record by years shows:

Net 1888	$5,070,570	Surplus after div	$456,363
Net 1887	4,037,281	Surplus after div	2,692,352
Net 1886	3,919,855	Deficit after div	14,170
Net 1885	5,700,924	Surplus after div	166,536
Net 1884	6,610,435	Surplus after div	498,915

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Sept. 14, 1891.

American Institute of Electrical Engineers.—The 59th meeting of the Institute, and the first of the present season, will be held at 12 West 31st street, N. Y. City, on Tuesday evening, September 22d, at 8 o'clock. A paper will be presented by Prof. Harris J. Ryan of Cornell University, "On the Relation of the Air Gap and the Shape of the Poles to the Performance of Dynamo Electric Machinery." Members who are especially interested in the subject, may secure advance copies upon application to the secretary. The Council will meet in the Secretary's office at 5 P.M. on the same day.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Sept. 12. 1891.

Mr. Wm. H. Gallison has just issued a new and complete catalogue of Engineers' Specialties.

The Thomson-Houston Electric Company pays $10,532 taxes in Lynn and the Thomson Electric Welding Company $1,460.

Thomson-Houston Sales.—One of the largest single sales of electric lighting apparatus ever made by the Thomson-Houston Company was effected week before last, and consisted of 4,000 incandescent and 600 arc lights.

The West End Street Railway, in Charlestown, is being relaid, for the electric system contract calls for the completion of this work within 90 days, and it is expected that the electric system will be running in that district before the snow flies.

The West End Street Railway Company is preparing to heat a large number of electric cars by electricity the coming winter, taking the current from the trolley wire. This act of the company will be greatly appreciated, especially by suburban residents, and shows in this as in other matters relating to the public's convenience and comfort that the West End is alive to their mutual interests.

The New England Engineering Company, of Waterbury, Conn., in the interests of a syndicate has purchased the present lighting plant at Elizabeth, N. J., and all its franchises. It will immediately build a new lighting and power plant, installing to begin with a 1,500-h. p. Corliss engine. The New Johnston City & Carnegie Street Railway at Johnston City, Tenn., which was installed by the company, carried 1,200 passengers with three cars during the first five hours of its operation.

Messrs. Jerome and Harvey Redding have retired from the Redding Electric Company and resumed business at the old stand, 48 Hanover street, Boston, under the old name of Jerome Redding & Co., where they will continue to manufacture their well known specialties, and will keep a full line of electric supplies as heretofore; they will also continue the wiring of buildings. This in no way affects the Redding Electric Company, it being a mutual agreement, and pleasant relations exist on both sides.

Eastern Electric Supply Company.—At the annual meeting of this company, held Friday last, the following officers were elected: Mabin W. Brown, president and manager; W. P. Ferguson, vice-president; Albert Otis Smith, secretary and treasurer. L. A. Dean Dean and D. J. Hearn, with the officers, will constitute the board of directors. As will be noted, Mr. Ferguson is a new acquisition. He is a railroad man of large experience, and is well and favorably known among the electrical interests, and Mr. Brown and his associates are to be congratulated on this accession to their company.

The Electrical Specialty Company, of Pawtucket, R. I., is manufacturing and placing on the market a number of very useful specialties that are meeting with success in every way. Among them we may mention the Thomas mast arm, which actual experience has proved will show a large gain in the power of the lamp over the ordinary arm, using any manufacture of lamp. Some of the specialties are the carbon holder, pole step, cut-out box, load changer, lamp insulator, and many others, combining a simplicity, durability and moderate cost, which qualities should, and undoubtedly will, recommend them to the trade generally. Their popularity is shown already by repeated orders received from those using them now.

C. A. B.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 The Rookery, CHICAGO, Sept. 12, 1891.

East Lincoln, Neb.—The Electrical Manufacturing Company has shut down for several weeks in order to make improvements.

Pueblo, Colo., is to have a large plant to reduce ores by electricity. It is not an experiment, having been tried with success.

Mr. Frank N. Waterman, who has had charge of the new electric road at Burlington, Ia., called on a number of his Chicago friends week before last.

Mr. H. I. Hadaway, who recently joined the forces of George Cutter, has been making a very successful trip through southern Illinois in the interest of the improved Schaefer lamp.

Mr. W. S. Jewell, the new superintendent of the Citizens' Street Railroad at Indianapolis, made another call on the electrical dealers at Chicago recently. His road is being improved and extended quite a little.

East Liverpool, O.—The Akron Electrical Manufacturing Company has signed a contract to place ten of its Loomis fire alarm boxes in the city fire alarm circuit of East Liverpool. A number of private boxes will also be supplied.

Pana, Ill.—The Springfield Electric Light Company has sold its plant and franchise to the Modern Electric Light, Power and Railway Company for $17,000. The latter company will change the street lamps, and put in a street railway.

Mr. George Foster, who until recently was traveling for the Illinois Electric Material Company, is now connected with the drafting department of the World's Columbian Exposition. C. L. Etheridge, one of this year's Cornell graduates, is also on the staff of designers.

The Phœnix Automatic Filter Company, of Racine, Wis., have materially improved their filters during the past year, and are keeping a larger variety of sizes in stock than formerly. On account of pressure of business the factory force of this company has been recently doubled.

Mr. C. E. Lee, who lately had charge of the house goods and fixture department of the Great Western Electric Supply Company, has now taken the agency for the Electric Gas Lighting Company,

of Boston. He will have his headquarters at Chicago, and will look after the needs of dealers in this vicinity.

Elgin, Ill.—C. E. Jones, R. N. Botsford, Flavius R. Allen and two or three Elgin people are interested in a proposed electric heating company. The above-named are to be the incorporators; the name of the company is to be the Elgin Electric Heating Company, and the capital will be $10,000. Mr. Jones is the inventor of an electrical sad-iron, and the company proposes to make these irons, together with machines for general heating. F DE L.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, Aug. 26, 1891.

Mr. Nikola Tesla's Experiments.—Paragraphs have been going the round of the leading daily papers in London and the provinces relating to Mr. Nikola Tesla's recent experiments. It is to be hoped that this gentleman will shortly succeed in perfecting his apparatus, otherwise the many hundred readers of these aforesaid paragraphs will be sorely disappointed, since they leave an impression that electric lighting in this style is practically an accomplished fact.

Church Lighting.—Electric lighting, not a moment too soon, is gradually making its way into our churches. One of the latest to adopt electricity is an old city church, by name "St. Nicholas Cole Abbey." The rector states that he has taken this step "to relieve the congregation of the unfavorable atmosphere of the gas which put the organ out of tune and the people out of temper, spoiled the colors on the walls and ceiling, and did harm to the health of not a few of us." If the congregations of other churches in the United Kingdom are exposed to the same dangerous conditions, an act of Parliament making electric lighting obligatory would seem to be an absolute necessity.

City Lighting.—The gas journals have not been slow to minimise the prospects of the City of London Electric Lighting Company and the city papers are now beginning to cry out against the "Brobdignagian columns to be erected without rhyme or reason in some of the narrowest footpaths." The standards put up by the Brush company are fairly artistic and are surmounted by frosted lanterns. On the other hand the standards put up by the Laing, Wharton & Down Construction Syndicate are surmounted by Thomson-Houston arc lamps in all their native ugliness, and to make matters worse the posts are painted a most brilliant red, so that they irresistibly recall to mind pictures of the notorious "Lanterns" of Paris. Perhaps the promoters are of opinion that a revolutionary system of lighting should be heralded by revolutionary colors.

Death of the Postmaster-General.—The death is announced of Mr. Henry Cecil Raikes, Postmaster-General. His sudden decease is attributed to prostration and collapse from pressure of official duties, although it is perhaps worthy of notice that a short time ago he was struck by lightning while riding, the shock of which may possibly have had something to do with the symptoms which proved fatal to him. Mr. Raikes' tenure of office has been signalized by considerable innovation and no little friction. In the Telegraph Department of the post office he has had to deal with open mutiny on the part of the operators of the London Central Telegraph Office, and he had a still more unfavorable state of things to cope with in the case of the letter sorters and carriers. In the opinion of many competent officials Mr. Raikes was one of the ablest and most conscientious postmasters general we have ever had.

Electric Welding.—The Electric Welding Company (Limited), with a capital of £460,000, has just come before the public. Of the 25,000 ordinary £10 shares, one-third have been taken by the vendors, the Thomson-Houston Company. The ordinary shares are entitled to a cunmulative dividend of 10 per cent., the surplus being shared between them and the founders' shares. Favorable reports on electric welding are presented by Prof. Abed Kennedy and Sir Frederick Bramwell. The company proposes to follow the same system as has been adopted by you, namely, charging so much down for each machine and a royalty of one-half pence per weld. The estimate of profits is, as is usual in such cases, somewhat sanguine. Electric welding has now been before the American public for several years, and yet only 100 machines are stated to be in use in the whole of the United States. Notwithstanding this, the estimated income for the first year is based upon the probability of 100 machines coming into use in the United Kingdom within the first twelve months. If it has taken several years for 100 machines to come into use in such a large and novelty seeking country as the United States, the probability of 100 being required in the United Kingdom in twelve months is somewhat small, especially when the irritating system of royalty per weld is taken into account.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Life of Series Lamps.—We run series lamps on an arc circuit, and have one socket that has burned out four lamps in two months, while three others beside it in the same circuit have not burned out any lamps in a long time. What is the cause?

F. M. G.

If yours is a continuous current system the trouble is due very likely to the fact that the resistance of the lamp coil is too high, thus causing an abnormal flow of current through the lamp shunted across that coil. With the Westinghouse system the flow could be caused either by too much iron in the shunt box or too much ohmic resistance in the shunt coil.

Magnetic Field of a Dynamo.—(1) The field of a dynamo is excited past six million lines of force from pole piece to pole piece; of these five millions pass through the armature core and one million leak around through the air. Do the one million that leak around counteract one million that pass through the armature and so reduce the efficiency to four millions? (2) Why is a dynamo provided with extended pole pieces? W. D. L.

(1) You only lose the one million that leak through the air. (2) A dynamo is provided with polar extensions for the purpose of reducing the resistance of the air gap, or increasing its section, and also of rendering the induction uniform over the armature. The other question you ask is too indefinite to permit an answer.

News of the Week.

THE TELEGRAPH.

Redlands, Cal.—The work of putting in the new telegraph line is progressing rapidly.

Lake Stevens, Wash.—A new telegraph station is building at Messimer's Spur for the benefit of Lake Stevens folk and vicinity.

South Bend, Wash., is to have a temporary telegraph line. It will be 56 miles in length, 24 of which from Chehalison will be a permanent plant.

Seattle, Wash.—The Seattle *Times* says that the Pacific Postal Telegraph Company is constructing a new line to the south over the Commercial street trestle.

Youngstown, O.—Mr. George N. Blose, of New Castle, has been appointed manager of the Postal Telegraph Company's office at Youngstown, to succeed Mr. J. C. Dukes, who resigned.

Chattanooga, Tenn.—The Postal Telegraph Company's business has so increased that it has established an office at the Staton House, with J. E. Naville, formerly of the Ninth street office, in charge.

THE TELEPHONE.

Roanoke, Ala., is to be connected with Wedowee by telephone.

Delano to Watertown, Minn.—There is talk of a telephone line from Delano to Watertown.

Nebraska City to Percival, Neb.—A telephone line from Nebraska City to Percival is being constructed.

Golden to Rubyville, Colo.—A telephone line is to be built from Golden to Rubyville, the Denver Coal Company's camp on Ralston.

Glenbrook to Tallac, Nev.—The telephone line has been extended from Glenbrook to Tallac. It connects at Hobart, Averill's and Bijou.

Montgomery to Wetumpka, Ala.—The new telephone line between Wetumpka and Montgomery is expected to be in working shape about Sept. 15.

New Lebanon, N. Y., and Pittsfield, Mass.—The telephone line between New Lebanon and Pittsfield is being rebuilt with larger poles, and cross irons instead of brackets.

Montreal, Canada.—The Telephone Company has notified subscribers that at the expiration of their contracts the rates will be advanced as follows: For dwellings, $25 to $30; for doctors, $25 to $35, and for general business offices, $25 to $50. The company claims that it is losing money at present rates, and that the advance is necessary to put the company on a paying basis.

Oakland, Cal.—The Sunset Telephone Company has been requested to furnish the city with free telephone privileges. The appeal is made on the ground that the company has no franchise from the city to erect poles and wires in the streets, but that it does so whenever and wherever it pleases. The Western Union Company is in the same box as regards having no franchise.

THE ELECTRIC LIGHT.

Lake City, Colo., is soon to have electric lights.

Granville, O., is to have a new $5,000 electric light plant.

Odebolt Ia., is considering the question of electric lights.

Hampton, Ia., has hopes of soon being illuminated by electricity.

Versailles, Ky., expects to have its new electric light plant in operation by Oct. 1.

Chester, Ill.—The State's prison and insane asylum are being wired for electric lights.

Windsor, Mich.—Stock is being subscribed for an incandescent electric light company.

Columbus, O.—The Edison Electric Light Company has been given the contract to furnish 40 incandescent lights for the council chamber at $150 per year.

Hartford, Conn.—Beginning Oct. 1, the electric light company will run their dynamos 24 hours a day, for the purpose of supplying motive power as well as light.

Albuquerque, N. M.—The Electric Light Company is putting in 20 of the latest improved arc lights. They are being placed at the principal street crossings in the city.

Grand Rapids, Mich.—A new boiler house with two additional boilers of about 300-h. p. capacity is to be erected on Canal street by the Edison Electric Light Company.

Newport News, Va.—Two electric light plants are being erected at Newport News, one at the shipyard to light the $3,000,000 plant there, the other in the town at Virginia avenue.

Portland, Conn., is to have electric lights. The Germania Electric Company of Boston is to construct the works, and will own a portion of the stock. The entire amount is 220 shares at $100 each.

Kansas City, Mo.—The stockholders of the electric light plant purpose enlarging the plant, erecting a large new building, adding new engines, etc., and making the plant a first class one in every respect.

Saratoga, Wyo.—An electric light plant and flouring mill are to be started at Saratoga. Power from the Platte River will be utilized. Mr. S. C. Clark, of Washington, will put in the plant, which will cost $25,000.

Kansas City, Mo.—The county court has awarded the contract for furnishing the electric light apparatus for the new court house to L. C. Baer on a bid of $2,350. The county jail contract was given to Thomas F. Clohesy, on a bid of $918.

New Brighton, Pa.—The contract for lighting New Brighton for five years with 60 or more 1,200 nominal candle power arc lights was given to the lowest bidder, the Beaver Valley Electric Light and Power Company, at $59 per light per year.

Elmira, N. Y.—The contract for furnishing a 600-light compound incandescent machine for lighting the new additions to the New York State Reformatory at Elmira has been awarded to Mr. S. N. Blake, of the Mather Electric Company, of Manchester, Conn.

New York.—The Temple Emanu-El, at Fifth avenue and Forty-third street has a new system of electric incandescent lighting, between 500 and 600 have been arranged in striking effects. Electricity has taken the place of steam as a motive power for the organ.

Chicago, Ill.—The contract for the electric light plant for the Masonic Temple in Chicago has been awarded. It will be one of the largest isolated plants in the world. The generating plant will consist of six 80,000-watt generators, and between 7,000 and 8,000 lights will be wired.

Meridian, Miss.—The Edison Electric Light and Power Company of this city, closed a contract with the Skinner Engine Company of Erie, Pa., for two large engines and boilers of 200-h. p. for their electric light and power plant, which they expect soon to have in full operation.

Granville, O.—Bids for the erection of an electric light plant have been received by the city clerk of Granville. The estimates were made on a probable basis of $5,000; there were eight bidders, the lowest being the Thomson-Houston Company at $4,717, which company will probably get it.

THE ELECTRIC RAILWAY.

Menominee, Mich.—The old horse cars are being changed so as to run by electricity.

North Andover and Methuen, Mass.—The trial trip over the electric railway connecting North Andover and Methuen was a success.

Harrisburg, Pa.—The East Harrisburg Electric Railway Company has completed its connection with the Harrisburg passenger railway company lines.

Duquesne, Pa.—The White Electric Traction line from Riverton bridge to Blind Lane, Duquesne, has been completed, and electric cars will soon be in operation.

The Star Electric Company, of Illinois, has bought the seven miles of horse railway in Clinton and Lyons, and Fulton, Ill., and will make an electric line of it.

Le Mars, Ia.—Efforts are being made to get a franchise for an electric street car line; it is quite likely it will be granted and that the line will be operated from the same power house as the light company.

The Worcester, Leicester and Spencer Electric Street Railway is now open for public traffic over its entire length, and a banquet was given in honor of the event on Sept. 8 at the Massasoit House, in Spencer.

The West End Street Railway Company has exercised its option to take over its repair account from the Thomson-Houston Company, and this will be done Oct. 1. The contract could have been continued in force at the option of the West End company for five years or until 1895.

A Thomson-Houston Sale.—The West End Street Railway Company has contracted for cash purchase from the Thomson-Houston Company of electrical equipment for 250 cars, including 500 street railway motors, but not the car trucks or car bodies. The purchase will amount to over $500,000.

The American Street Railway Association announces through its secretary that the rate of a fare and one-third has been allowed to delegates and all others, including members and their families, in attendance at the 10th annual meeting of the association which will be held in the city of Pittsburgh, Pa., October 21-23, 1891, by the following traffic associations, namely: Boston Lines Passenger, Central Traffic, New York and New England Passenger, Southern Passenger and Trunk Line; also on the Chicago & Alton Railroad from all points in the State of Illinois. Michigan is excepted from the Central Traffic Association's offer. This covers nearly all of the territory of the United States, with the exception of that controlled by the Western Passenger Association.

Annual Meeting of the Massachusetts Street Railway Association.—The annual meeting of this association was held at the Bay State House, Worcester, Sept. 9, some 30 members being present. The following officers were elected: President, Charles B. Pratt, Worcester; first vice-president, Amos F. Breed, Lynn; second vice-president, Frank S. Stevens, Fall River; secretary and treasurer, James H. Eaton, Lawrence; executive committee, Percy Parker, of Lowell; Henry A. Willis, of Fitchburg; A. E. Smith, of Springfield; Joseph Tucker, of Pittsfield; W. W. Cross, of Brockton; S. C. Hart, of New Bedford; F. H. Monk, of Boston; John Q. Adams, of Quincy, and E. P. Shaw, of Newburyport. A dinner was served, after which there was an informal discussion on the use of electricity as a motive power. The party took a ride over the new electric railway to Lake Quinsigamond.

GENERAL APPLICATIONS OF POWER.

The Monongahela Coal Fields introduced electric coal mining machines some two years ago, and since that time their use has largely increased. One of the latest mines operated by these machines is the O'Neil & Peterson mine at Bunola on the Pittsburgh and Belle Vernon Railroad, on the Monongahela River. The Michaels Electric Coal Mining Machine Company, of Pittsburgh, contracted to supply the equipment, which consists of one 50 h. p. steam engine, one 30 h. p. Westinghouse alternating current generator, and eight machines with the Tesla motor of the Westinghouse Electric and Manufacturing Company attached to each machine. The success of the Michaels coal mining machine has long passed the experimental stage, having been in practical operation for 15 months. The capacity of each machine per day is 65 tons of coals, or about one square foot of undercut per minute for ten hours a day. Only one man is required to attend the machine.

MISCELLANEOUS NOTES.

London Electrical Exhibition.—The Electrical Exhibition to be held in the Crystal Palace has been postponed from November, 1891, to Jan. 1, 1892, on which date it will be formally opened. It is intended to make it as perfect as possible a display of the latest novelties in electrical science.

PERSONAL NOTES.

Mr. David N. Cook has retired from the position of superintendent of the Essex Electric Street Railway.

Mr. N. H. Edgerton, at the meeting of the Franklin Institute in Philadelphia Sept. 8, delivered an address on "A New Storage Battery."

Prof. Edwin J. Houston delivered an address on the "The Artificial Production of Rain" before the Franklin Institute, Philadelphia, on Sept. 8.

Mr. Erastus Wiman and 25 other representative business men of New York visited Boston last week for the purpose of investigating its electrical railway service.

Mr. A. F. Hasselman has been appointed manager of the Western Union Office at Cedar Rapids, to suceed A. F. Groeltz, who resigned to engage in other business.

Mr. Park Sells, formerly engineer of the electric light plant at Pontiac, Ill., has been promoted to the general superintendency of the Edison Electric Company of Chicago.

Mr. C. L. Boyce, formerly general electrician for the Telephone and Telegraph Construction Company, of Detroit, recently resigned that position to become superintendent of the Fisher Electrical Company.

Mr. Ross McMahon, who has been connected with the North American Telegraph Company, of Dubuque, Ia., for some three years, has accepted the position of manager of the Western Union office at Maquoketa, Ia.

Mr. Maurice Mueller, for the past ten years the engineer and chief of the technical department in the United States Electric Lighting Company, has taken a similar position with the Weston Electrical Instrument Company, of Newark, N. J.

LEGAL NOTES.

Ball Engine Suit.—In our issue of Sept. 5 we published an item stating that we had been informed that this suit had been decided in favor of the Ball & Wood Company, of New York. We have now received the following statement in a letter from the Ball Engine Company in reference to that item: "We wish to say that this report is untrue. The case in question has not been decided, and we ask you, in justice to us, to correct the statement."

Industrial and Trade Notes.

M. D. Porter, of New York City, manufacturer of electric motors, has as many orders on hand as he can conveniently handle, and new orders are coming in upon him. His motor is certainly doing splendid work, judging from the compliments he is receiving verbally and through the mails.

Mr. W. S. Chesley has sold a 650-light Edison dynamo to the Plaza Hotel, this city; also a 30-light Brush arc dynamo to Western parties. He has recently received a lot of new dynamos, and has now a very large stock to select from. Parties wishing to buy or sell should communicate with him. Mr. Chesley reports business brisk in his purchasing department.

The Eureka Tempered Copper Company, of North East, Pa., has added 50 feet to its factory, which is now 200 × 50 feet. It has also added 12 immense copper furnaces to the finishing department, and a large line of new tools. An additional number of workmen have also been employed. The company is, as usual, very busy. Its electrical trade is increasing constantly, many manufacturers specifying its copper with their orders.

The Eastern Electric Supply Company, of Boston, by its new arrangement, of which notice is given in another part of the paper, becomes a very prominent factor in the supply line both in the field of electric lighting and street railways. This company is only about one year old, but the strict business principles followed by it have quickly placed the company in the front rank. Negotiations are now in progress whereby the company will probably control the output of one of the largest factories in the East, manufacturing supplies of all kinds.

Messrs. D. Frisbie & Co., of 112 Liberty street, New York, are meeting with great success in the sale of their new direct electric elevators, friction clutches and hoisting machinery. Last week they sold five elevators, three of them being direct, and they have orders on hand for 19 more. The new electric hoists manufactured by this company, and with which are combined the Frisbie friction devices are now in use in several large coal elevators, and orders have been received from numerous western miners for more of these machines.

The Samson Cordage Works, of 115 Congress street, Boston, make a specialty of solid braided cords for hanging arc lamps, and for street car trolley cord. The manufacturers recommend the water-proof finish, though the plain finish is most often used and gives satisfaction. The material most in use is cotton, as it has been found from long trials that cotton loses less in strength when exposed to the weather than either hemp or linen. The cord is made in different sizes, that for trolley cord being one-fourth inch in diameter. The smaller sizes down to one-eighth inch are used for winding the field magnets of dynamos as a protection for the wire and for this purpose they are well adapted as they do not kink.

Emerson Power Scale Company.—In a circular letter recently mailed by the Emerson Power Scale Company it calls attention to the work done by its engineering department during the past year. The questions involved were principally those of obtaining the greatest economy in the use of power, ascertaining the amount of power used, amount of power developed by, and efficiency of, water wheels, electric motors and engines. Among the number who availed themselves of this company's services are the following: New England Electric Company, Boston; Thomson-Houston Motor Company, Boston; Woonsocket Electric Machine and Power Company, Woonsocket, R. I.; Edison Illuminating Company, Boston and the Ball Engine Company, of Erie, Pa.

Business Notice.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Co., of 105 South Warren street, Syracuse, N. Y.

The Hine Eliminator Company, 106 Liberty street, New York, report an excellent business during the past month. Among those to whom their "Eliminator" was sent they mention the Pardue Institute of Lafayette, Indiana, for use upon their electric laboratory engine, and the Cedar Rapids (Iowa) Electric Light Company. The very high efficiency their eliminator demonstrated (98.8 per cent.) in the test of steam separators, recently made, at Cornell University, puts it far to the front of other like competing machines. The company has published in neat pamphlet form the complete text with diagrams of Prof. R. C. Carpenter's report of the Cornell test, which will be sent to any address. It contains points of interest to engineers, and important information for owners of steam plants contemplating the use of a steam separator or an oil and grease extractor.

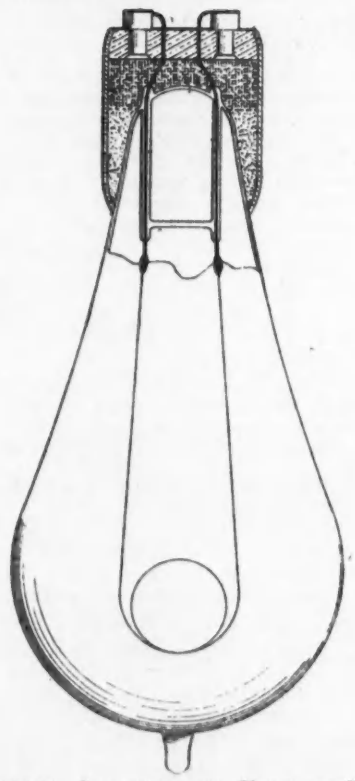
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED AUG. 8, 1891.

459,013. Telegraphic Transmitting Apparatus; Morris Martin, of Malden, Mass., Assignor by direct and mesne assignments to the United States Electric Fire Signal Company, of Maine. Application filed July 14, 1890. The combination of a motor and detent therefor with two electro-magnets and armatures, each operatively connected with the motor-detent, and a circuit having two nominally closed branches, each including the coils of one of said detent-magnets, and being extended through an exposed locality and containing thermostatic circuit controllers therein, whereby the breaking of one of said branches affects the corresponding magnet and causes it to release the motor-detent, but a breakage of both of said branches is required to break completely open the said circuit.

459,024. Mounting for Motors of Electric Cars; Sidney H. Short, of Cleveland, O., Assignor to the Short Electric Railway Company, of same place. Application filed Dec. 24, 1890. In accordance with the present invention the axially placed and directly connected armature is combined with field magnets, which are provided with bearings on the car axle and also at points in at least two vertical planes parallel with the axis of the car axle and preferably on opposite sides of said axle, so that the centre of gravity of the field magnets is between said planes. (See illustration.)

459,070. Electrically Heated Wristband Ironer; Willis Mitchell, of Malden, Mass., Assignor to the Butterfield-Mitchell Electric Heating Company. Application filed Nov. 29, 1890. The invention consists in the combination of a fixed heating plate having a stem with a coiled wire, and its inclosing casing sleeved on the stem and supported by its plate, the wire forming part of an electric circuit and heating the plate.



No. 459,100. INCANDESCENT ELECTRIC LAMP.

459,088. Electric Light Fixture; Edwin T. Greenfield, of New York. Application filed May 11, 1891. A universal socket for an incandescent electric lamp or analogous translating device, having a fixed central terminal provided with an inner and an outer contact surface, in combination with a peripheral contact provided with a lateral branch.

459,100. Incandescent Electric Lamp; Edward P. Roberts, of Cleveland, O., Assignor to the Swan Lamp Manufacturing Company, of same place. Application filed July 15, 1891. The invention consists in the combination, with an incandescent electric lamp and a socket-piece, of sealing material for connecting said lamp and socket-piece, and absorbent material adapted to make contact with the sealing material and end of the lamp or bulb, and means for retaining said absorbent material in place. (See illustration.)

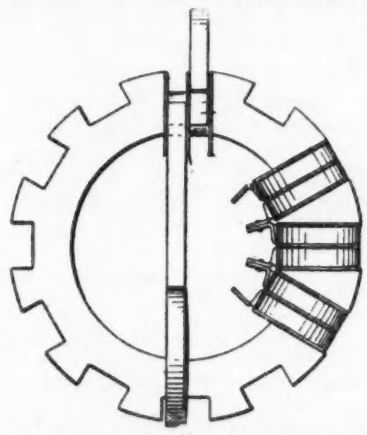
459,127. Electrode for Chairs; George Whitfield Overall, of Memphis, Tenn. Application filed July 8, 1891. A seat, an electrode upon said seat, a back secured to the seat, an electrode adjusted upon the back, and a switch connected with the battery, said switch having contact points connected with the electrodes, whereby the electrodes may be placed in electrical connection with the battery.

459,143. Electro-Therapeutic Truss; Hugh W. Matthews, of Chicago, Ill. Application filed June 26, 1891. An electro-therapeutic truss provided with a battery and leads therefrom, an electrode of rubber containing an electrode faced with a sponge, and a yoke provided with electrically-connected metal sockets and sponge-faced electrodes removably held in said sockets.

459,144. Electro-Therapeutic Belt; Hugh W. Matthews, of Chicago, Ill. Application filed June 26, 1891. An electric belt provided with a battery and metallic sockets fixed in said belt and connected to said battery and electrodes provided with spring buttons and adapted to be received and removably held in said sockets.

459,168. Support for Electric Conductors; George H. Winslow, of Pittsburgh, Pa. Application filed May 19, 1891. A support for electric conductors, having one or more plates provided with clamping jaws adapted to engage the conductor, and a rod or bar provided with prongs journaled in said plates and constructed, when turned in normal position, to press the jaws against the conductor.

459,205. Telephone Receiver; James H. Howard, of Medford, Mass. Application filed March 3, 1891. The combination, with a telephone receiver, of two contact pieces on the exterior thereof, one connected with one end and the other with the other end of the wire forming the coil in the receiver, two spring-pressed contact pieces connected with the circuit wires and normally held by their springs in contact with the contact pieces of the receiver,



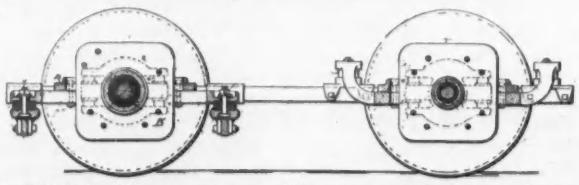
No. 459,366.—ARMATURE FOR DYNAMO ELECTRIC MACHINES OR MOTORS.

said spring-pressed contact pieces being movable out of contact with the pieces on the receiver when the latter is not in use, and means for electrically connecting the spring-pressed contact pieces externally of the receiver when the said spring-pressed pieces are not in contact with the contact pieces on the receiver.

459,213. Hook or Crotch for Telephone Receivers; James H. Howard, of Medford, Mass. Application filed March 3, 1891. In a telephone receiver hook or crotch, the combination of the main arm having a cross piece, a bracket to which said main arm is pivoted, a contact piece, a spring normally holding the said cross piece in electrical connection with said contact piece, and a shelf upon which the receiver is supported when displacing the cross piece from contact with the contact piece.

459,214. Telephone; James H. Howard, of Medford, Mass. Application filed March 3, 1891. An attachment to a Siemens armature, consisting of a crank shaft mounted in suitable relation to the shaft of the armature, a segmental gear mounted on the said crank shaft meshing with a gear on the armature shaft, a crank or lever adapted to rotate said crank shaft, and a reacting coil spring on said crank shaft, whereby the same is rotated in the contrary direction when the said crank or lever is released, a disc on the crank shaft having the greater portion of its periphery and connections between the said spring and the bell magnet.

459,219. Electric Switch; Lewis D. Castor, of Philadelphia, Pa., Assignor to William H. Weston & Co., of same place. Application filed May 20, 1891. In an electric switch, an arm or lever having guides and springs connected therewith and passing through said guides, and terminal plates and insulating pieces continuous therewith, said pieces being provided with shoulders whereby the springs are permitted to drop from said plates upon said pieces, thus closing and breaking the electric circuit.



No. 459,024.—MOUNTING FOR MOTORS OF ELECTRIC CARS.

459,222. Electrically Operated Brush; Frederick A. Lehmann, of Washington, D. C. Application filed Oct. 25, 1890. In a revolving electrically operated brush, the combination of a handle which is formed by the field magnets, a shaft which extends longitudinally between or through the field magnets or handle, the armature secured to one end of the shaft, and the revolving brush secured to the other, the brush being made to extend in a straight line with the handle.

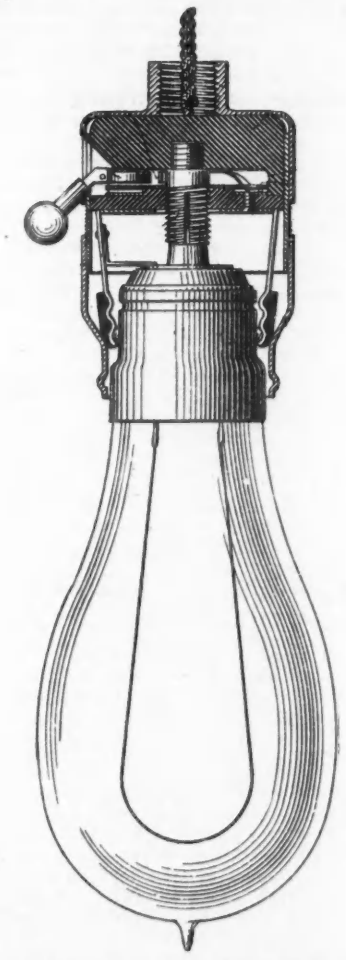
459,229. Electric Elevator; Harry H. Blades, of Detroit, Mich. Application filed Sept. 19, 1890. An elevator having an electric motor for operating the same, located on the elevator cab, and a counterpoise weight consisting of a storage battery adapted to supply said motor with operative current.

459,266. Hanger for Incandescent Lamps; Paul J. Chassagne, of Akron, O. Application filed Jan. 19, 1891. The combination of journals, a spring actuated roller which is insulated from the journals, stationary wires secured to the roller and which have their outer ends loosely connected with the journals, and the conducting wires secured to their inner ends.

459,321. Fuse and Detonator; Paul Ward and Edward Mammatt Gregory, of London, England. Application filed May 13, 1890. In an electric fuse or combined electric fuse and detonator, a glass receptacle fused over the two ends of the igniting wire or wires and fused at the other end after charging to form a hermetically closed impervious receptacle for the priming or priming and detonating charge.

459,323. Electric Contact Apparatus; Christian Weuste, of Duisburg, Germany. Application filed June 12, 1890. An electric contact apparatus having a rotating disc or body, contacts, stationary contact pieces, relatively arranged to the contacts for providing a guide-channel or passage way between the contacts and the cheek pieces, and a movable device lifted by the disc or body as it turns axially and deposited at a point above the axis of the disc or body into the guide channel or passage way to act upon and press the contacts into electrical connection.

459,366. Armature for Dynamo, Electric Machines or Motors; Robert Lundell, of Brooklyn, Assignor of one-half to Edward H. Johnson, of New York. Application filed Nov. 24, 1890. An armature having a ring or core and several coils thereon, said coils consisting of flat conductors, the convolutions of which are separated by fireproof material, and fireproof washers at the sides of said coils, whereby said bare conductors are surrounded on all sides when wound into coils by fireproof material. (See illustration.)



No. 459,088.—ELECTRIC LIGHT FIXTURE.

459,367. Commutator Brush and Holder; Robert Lundell, of New York, Assignor of one-half to Edward H. Johnson, of same place. Application filed April 4, 1891. The combination of a brush holder, a current collecting rod supported therein, a grooved cap on the rod, and a spring pressing on the cap and resting in the groove thereof.

459,368. Commutator Cylinder and Method of Making the Same; Robert Lundell, of New York, Assignor of one-half to Edward H. Johnson, of same place. Application filed April 4, 1891. A commutator cylinder composed of alternate conducting and insulating sections, a filling of insulating material between the cylinder and a sleeve or shaft on which it is mounted, and a straightening ring imbedded in said insulating material.

459,378. Electric Conductor; Edwin D. McCracken, of Alpine, N. J., Assignor to the Norwich Insulated Wire Company, of New York. Application filed March 5, 1891. The combination of an electrical conductor and loosely twisted ribbons of paper wound around the same.

459,385. Flexible Electric Conductor; Hosea W. Libbey of Boston, Mass. Application filed July 26, 1889. The invention consists in placing upon the electric wire oblong beads of glass or other non-conducting material with rounding ends and inserting them into an india rubber or other flexible tube.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.